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"She wrought her people lasting good.

. . . . . .

A thousand claims to reverence closed
In her as Mother, Wife, and Queen."

FLOWERING PLANTS,

WITH ILLUSTRATIONS FROM BRITISH WILD-FLOWERS.

By R. LLOYD PRAEGER, B.A.

I.—ROOTS AND STEMS.

WE cannot take a country walk without being struck by the variety of the vegetation which carpets the surface of the ground. Lowly as are most of our native plants in comparison with those which clothe the hills and valleys of tropical countries, we find notwithstanding an infinite variety in the forms assumed by their various parts, and we may note in our islands, as well as in a Brazilian forest, the crowding, the struggling for room, the way in which every nook, every coign of vantage, is occupied by growing plants. Those species which are best adapted for the conditions afforded by any particular situation and surroundings will achieve the most success in life; will grow healthy and strong, increase at the expense of their neighbours—for there is not room for all—and will eventually produce the greatest amount of seed, to scatter abroad and carry on the race. To achieve eventual success in this struggle for life, the most important point is no doubt the adequate propagation of the race; but as this can only be obtained by the success of the individual, it follows that every feature, however slight, which tends to the efficacy of the individual, is a distinct aid towards the success of the race.

The requirements of plants for the carrying on of life and growth are much the same as those which we ourselves might demand—namely, a certain amount of elbow-room, and of food and drink, light and heat. But most plants being fixed to one spot, and not capable of roaming at will, the conditions of their existence are somewhat different from those of the majority of animals. Their supply of water, and of most of the inorganic and organic substances which they need for the building-up of their bodies, must be drawn from the soil, in which they firmly fasten themselves; while for their supply of air and light they must largely depend on their own exertions, that by growth they may offer a sufficient surface to the atmosphere and to the light of day, and not allow their neighbours to unduly overshadow them.

The function of the ROOTS is twofold. They anchor the plant firmly in its place, so that storm or rain may not overturn it or carry it away; and they absorb from the soil, by means of minute hairs, the water needed in the plant's economy, and dissolved in this water the soil furnishes the plant with various mineral salts which are needed for its growth. The roots of plants offer a considerable variety of form. Annual plants have generally a much-branched root-system, not far-spreading. Examine, for instance, the roots of the Goose-foots or Oraches that on waste ground shoot up in a single season into pyramidal masses of foliage and minute green flowers, often three feet in height, only to perish with the first frosts of winter. In plants such as these, the rapid growth needs a continually increasing amount of root surface; this is acquired more easily by repeated branching than by the lengthening of a main root. Again, as the plant has not existed continuously for years on this particular spot, it has not already exhausted the soil immediately surrounding its root-stock, and in a limited area it finds nutriment sufficient for a single year's growth. A third consideration is that this elaborate structure of stems and leaves does not require to be safeguarded against the storms of winter, for

by the end of autumn its period of life is fulfilled; therefore a firm anchoring can be dispensed with. By way of contrast, consider the roots of a young tree. This plant has a long life before it, and the future must be carefully provided for. The roots are long and very strong and woody—much tougher often than the branches, for they are subject to greater stress. They spread widely, and hold the plant in its place with wonderful tenacity—as we realize when we try to weed out a few Ash or Sycamore seedlings that have got into our flower-beds. In the case of biennial plants, which during the first season of their existence form a rosette of leaves on a very shortened stem, and in the following year shoot up, flower, and die, the root is often much thickened, and used for the storing up during the first season of the plant-food required for the great vegetative effort of the second. Our larger native thistles furnish good examples of such foresight on the plant's part. Gardeners have taken advantage of this tendency of some species to enlarged roots to develop the character by continued selection of the most fleshy-rooted, and to their successful efforts we owe the juicy carrot, the corpulent turnip and beet, the salsify and parsnip. Biennial or perennial plants which dwell on arid plains, or in sandy ground, have particular need of long and fleshy roots, that they may store up food and water against times of drought, and in dry weather be able to tap the deeper damper layers of soil. If we examine the plants which grow on the dunes or on the sea shore, we shall find that many of them have a long fleshy tap-root which fulfils these purposes—the Sea-spurge for instance, and the lovely Horned Poppy. Note likewise the great length and succulence of the roots of the Sea-Holly. Aquatic plants live under peculiar conditions. Being wholly or in great part immersed in water, instead of air, the supply of water and dissolved salts is available to any part of the plant capable of absorbing them. Roots then become useful chiefly as anchors. In the quiet waters of ponds and ditches, even anchorage can be dispensed with, and we may find, as in the pretty Bladderworts, or the Ivy-leaved Duckweed, that roots have been altogether dispensed with; the plant forms a tangled mass of delicate stems among the other aquatic herbage, or drifts freely about on the surface under the influence of the wind. In certain exceptional cases, roots are used for purposes quite foreign to their usual functions. The Ivy, for instance, so long as it has a wall or tree-trunk to cling to, sends out from that side of its stem which is in contact with its support innumerable short roots, which fasten themselves so closely to the substratum that they will often drag with them scales of bark or pieces of plaster rather than relax their hold. These roots are generally used solely for the purpose of clinging, and the plant has in addition a well developed root-system in the soil below for the absorption of water; but they are true roots, and if on a damp wall we sever the stem, the upper part will continue to grow, fed by the clinging roots, which now take up the additional duty of supplying water.

Roots may even take on themselves the usual work of leaves, and develop chlorophyll, for the production, from the raw materials, of plant-food, in the presence of sunlight. The common Lesser Duckweed sends from the under surface of its floating fronds a bundle of little spirally twisted roots which hang down into the water, and help in no small measure to anchor the plant in its unstable substratum. These roots contain chlorophyll, and, being continually exposed to daylight, assist the green parts of the plant in carrying on that portion of the work which is in most cases performed by the leaves. But most roots, being buried in the ground, could make no use of chlorophyll, which can only fulfil its function in the presence of sunlight, and hence roots are usually not green.

In the case of the roots of most of our common leguminous plants we have, as Mr. Pearson has explained in KNOWLEDGE for October, 1900, a true symbiosis, or association of two separate organisms for their mutual benefit. In many other cases we find parasitism pure and simple, the advantages being entirely confined to one side. The curious Toothwort, for instance, has roots which, instead of absorbing nutriment from the soil, fasten themselves to the roots of other plants, penetrate their tissues, and draw therefrom a supply of plant-food ready made. In other cases the parasitism is only partial, as in the Yellow-rattle, Bartsia, and Eyebright of our pastures, which, in the keen struggle for mastery which goes on in these densely populated areas, take a somewhat unfair advantage by augmenting the food-supply which they produce by their own exertions by stealing from their neighbours by means of haustoria or suckers developed on their roots, which fasten themselves to the roots of adjoining plants. To this subject we shall have occasion to return when we speak of leaves and the part they play in the economy of the plant.

To turn now to STEMS. The stems of plants have two principal functions. They are the framework on which the leaves and flowers are spread out to catch the light and air, and they are the conduits through which the raw food materials are conveyed from the root to the leaves, and the manufactured plant-food distributed from the leaves to all parts of the organism. It is with the former use that we shall chiefly concern ourselves. The stems with which we are most familiar are those which rise into the air, generally branching as they go, and thus spreading the leaves and flowers over a considerable space, to allow all to receive their due amount of light and air; the form and structure of the stem-system depends directly on the size, number and shape of the leaves and flowers which it is designed to support. But first of all the duration of the stem must be considered. To take a few instances. In forest trees, such as the Oak or Beech, the stem lengthens year by year for a long period of time, branching at frequent intervals. To support such a huge and complicated structure under all circumstances, when loaded with leaves and fruit, or in the stress of winter gales, a stem of great strength and thickness is required. In such plants, as the stem lengthens and branches, it at the same time increases in girth year by year by means of fresh layers of woody tissue deposited underneath the constantly enlarging layer of bark; its strength to resist both compression and bending maintaining a due proportion to the weight and resistance to wind offered by the leafy boughs overhead. A great tree-trunk is the result. The trunk has many years in which to perfect its strength, and it becomes by degrees a solid column many feet in circumference of close-grained wood. The conditions are quite different in the case of an annual stem. Here the period of vegetative energy is strictly limited. The stem cannot be begun till winter is past, and must be finished in order that expanded flowers may give place to ripe fruit before winter sets in again. Hence rapidity of construction and economy of material are all-important factors in the plant's building operations. Look at the stem, often four to six feet in height, of a Wild Angelica or Cow-Parsnip, and note how beautifully it fulfils the requisite conditions. Each stem

supports several large leaves, and a number of heavy umbels composed of hundreds of flowers. Their weight is considerable, and as the leaves and umbels are often raised above the level of the surrounding herbage, wind-pressure is also a serious item to be provided for. The stems of these plants are upright hollow columns, strengthened by transverse partitions at intervals. Given a certain amount of material a hollow tube is the strongest form into which it can be moulded to resist pressure and bending. The plant has adopted precisely the form in which the building materials which have during the winter been lying ready stored up in the fleshy roots can be used to the greatest advantage. These heavy umbels must be kept with their flat surfaces horizontal, else the plant would lose the striking advantages which this complicated inflorescence offers: hence the necessity of rigidity. In many other plants with tall annual stems, the form of inflorescence is such that a temporary or permanent bending of the stem will not render the flowers less conspicuous, or otherwise interfere with their proper fertilization; in these a rigid stem is less required, and by bending to the storm the plant will lessen the chance of accident. Compare then with the stout rigid hollow stem of the Angelica, with its flat umbels of flowers, the thin flexible stems of the Meadow-Sweet, Purple Loosestrife, or Meadow-Rue that grow with it, all of which bend to the breeze that sweeps across the fields. The stems of water-plants offer a different set of conditions. Just as their roots serve as anchors rather than as gatherers of food and water, so their stems act as cables rather than as conduits The plant is buoyed up by the surrounding water, the stem has not to support its weight. It acts as a tie rather than as a strut, and flexibility and tensile strength replace rigidity and power to resist compression.

Climbing stems exhibit remarkable features which can only be briefly mentioned here. In plants like the Bryonies, Hop, Vetches, the stem is supported at many points by its convolutions, which embrace the support to which it clings, or by the leaf-tendrils which fulfil the same office. The stem is thus relieved of the task of supporting the weight of the plant, and serves chiefly as a conduit connecting with the root, and passing up water to the parts above. In these climbers the stem is thin, for strength is unnecessary, and it is flexible and tough, that it may easily follow the movements of the supporting plants. But it is the growing parts of such stems that exhibit such remarkable features. In these the rotating movement that characterises almost all the growing parts of plants attains a degree that is truly surprising; and along with this is developed an amazing sensitiveness which causes the stems or tendrils to bend towards and twine round any support with which, in their incessant movements of rotation, or circumnutation, they come in contact. Thus the climber progresses, feeling for and grasping everything that will help it in its journey to the light and air.

In a large number of plants the axis or stem is so compressed longitudinally, that, as we have hitherto understood the term, it might be said to be wanting altogether. Look at the Lesser Celendine, the Dandelion, the Daisy, and a hundred other wild-flowers. The stem is reduced to an exceedingly short root-stock, intervening between the roots on the one hand, and the point of emergence of the leaves and flowers on the other. Of stems that creep or lie prostrate on the ground, or burrow under the ground, there is a great variety. Prostrate stems, like those of water-plants, have not to support the leaves and flowers, and can afford like the latter to be thin and whip-like. Such are the stems of the Ground-Ivy and the Creeping Jenny, which produce leaves, flowers and roots throughout their whole length. The Strawberry, several of the native Cinquefoils, and other wild-flowers, exhibit two kinds of stems—short upright stems, or "crowns," which give off lateral prostrate stems or "runners" often many feet in length; the latter produce at various points of their growth tufts of roots below, and leaves and flowers above, which by the withering of the intermediate portions of the stem become in their turn separate crowns, to give off new runners. Subterranean stems may conveniently be grouped similarly into those which produce leaves and flowers throughout their length, or at intervals. In the subterranean stem a further modification takes place as compared with the erect stem. Most erect stems—and prostrate stems too—are coloured green with chlorophyll, that they may assist the leaves in the manufacture of plant-food. The underground stem has no opportunity of doing this, owing to the absence of daylight, and it is usually white, or of the dull colours that most roots affect. Underground stems have likewise little need of strength, except the quiet but well-nigh irresistible strength of growth, by which the apex of the stem forces its way through the soil. Their surface, too, being buried in damp earth, is less exposed to heat and dryness, and need not guard against excessive evaporation: hence we find that underground stems are frequently brittle, with a very thin epidermis or skin. These stems are excellent places for the storage of food-materials, which is the more necessary in such plants since, the stem being below ground, the leaves and flowers have to grow up often to a considerable height above the surface to secure a due amount of light and air, and perfect the fruit; hence subterranean stems are frequently thick and fleshy—look at those of the Butter-bur, for instance. An extreme case of the storage of food in stems is found in tubers, such as the potato. In these, a great amount of food-material is stored around a few buds, which lie dormant during the winter, and use the food-store in their rapid growth during the following season. Stems may altogether supplant leaves, and undertake the manufacture of the whole of the food of the plant. The Gorse furnishes a well-known example. The seedling Gorse has little trifoliate leaves like the Genistas, to which it is related, but as the young Gorse increases in size these leaves disappear, and the green stems carry on the work of leaves, and in addition undertake the defence of the plant against grazing animals by means of the stout thorns in which the branches terminate. This principle is sometimes carried further, and the stem becomes flattened and leaf-like, the better to carry on the work of assimilation. The Butcher's Broom supplies one of the most marked instances of this to be found among British plants. That the leaf-like organs of this plant are really stem-structures is rendered evident by the fact that the minute flowers of the plant are borne on their surface. The Duckweeds likewise furnish excellent examples of leaf-like stems.

Just as the sensitive root-tip bends downward from the commencement of growth, so the stems of most plants grow towards the light. In most plants this bending towards the light, or *heliotropism*, is more powerful than their *apogeotropism*, or tendency to bend away from the direction of the force of gravity. This is well seen when plants grow in a cave or recess; their

leaves and stems arrange themselves with respect to the direction of the source of light. Climbing plants are, however, but little affected by the direction of the source of light. If they were, they would frequently grow away from the structures which support them, which would be fatal to their continued climbing. Many, on the contrary, exhibit a marked *apheliotropism*, or turning away from the source of light. The Ivy, for instance, in its growth keeps the tip of its shoot pressed against the wall or trunk to which it clings, and will follow the supporting surface into the darkest nook. And climbers like the Bryonies and Vetches will grow right up through the dark centre of a hedge, while the surrounding plants bend away from the hedge, seeking the light on either side.

LIVING MILLSTONES.

By R. Lydekker.

The mill-like action of their own upper and lower molar teeth upon one another may have been quite sufficient to suggest to our prehistoric parents the idea of opposing a pair of corrugated stones in such a manner that by mutual rotation or revolution they should be capable of reducing to powder hard substances placed between them. Indeed the idea of millstones is such a simple and natural one that it is quite probable it may have occurred to the human mind without reference to any prototype in nature; and, in any case, if such a natural prototype is to be sought, it is not necessary to go further in search of it than our own dental organs. Excellent, however, for their special purpose as are these organs (when not subject to premature decay), there are other types of tooth-structure to be met with in the animal kingdom which present a much closer approximation to millstones, and might well have foreshadowed these instruments, had they only been accessible to the primeval savage. But since these natural millstones occur only in marine fishes, some of which inhabit distant seas, while others are met with only as fossils deeply buried in the rocks, it is evident that the idea of artificial millstones is not derived from these natural prototypes. In other words, to use an expression now fashionable in natural science, the development of artificial and natural millstones is a case of parallelism.

In spite of the fact that their early ancestors were provided with a good working set of sharply pointed dental organs, birds in these degenerate days manage to get along without teeth at all. A few mammals, too, like the South American anteaters, are in the same condition; and some people have thought that in a few more generations civilised man himself will be reduced to the same toothless state. The great majority of mammals, however, possess a more or less efficient set of teeth, varying in shape, size, and number according to the need of each particular species or group. But there is one feature common to these organs in mammals of all descriptions; and this is that they are strictly confined to the margins of the jaws, never extending either on to the palate, or to the space enclosed between the two branches of the lower jaw. In many reptiles, such as crocodiles and a large number of lizards, the same law of dental arrangement obtains. In some lizards, and still more markedly in certain extinct members of the reptile class, we find, however, a number of teeth developed on the palate, having flattened crowns, and thus tending to make the mouth act the part of one large millstone. But we must descend a stage further in the scale of animated nature before we come to structures which are strictly comparable with artificial millstones and crushing cylinders. And it is in the class of fishes that we meet with these organs

1. 2. 3.

Fig. 1.—A Dental Plate of a Beaked Eagle-Ray (*Rhinoptera*).

Fig. 2.—Imperfect Dental Plates of a Palæozoic Shark (*Cochliodus*).

Fig. 3.—Some of the Lower Crushing Teeth of an Enamel-scaled Fish (*Cœlodus*).

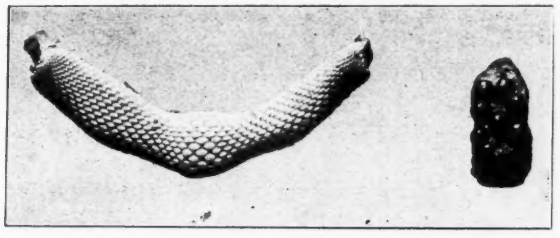
in the full perfection of this type of development. Not that they occur by any means in all the groups of that class; the fact being that at the present day living millstones are going out of fashion, the great preponderance of modern fishes having their dental armature mainly restricted to the margin of the jaws, with or without a minor development of crushing teeth on the palate or the bones of the gullet. With the exception of a comparatively limited number of cases, showing a different type of development, to which it is not my present intention to allude, these dental millstones are confined at the present day to those hideous marine fishes commonly known as skates and rays, and to the singular Port Jackson shark and a few allied species inhabiting the Pacific and Malayan seas. On the other hand, the seas of the Cretaceous, Jurassic, and antecedent epochs absolutely swarmed with numerous kinds of sharks, more or less nearly related to the Port Jackson species, whose mouths were filled with pavements of teeth showing marvellous variety of structure and beauty of ornamentation. The skates and rays, too, displayed types of dental millstones quite unlike any of those of the present day. And in addition to these, there were hosts of enamel-scaled fishes whose mouths were likewise crammed with beautiful crushing teeth, albeit of a totally different type of structure to that obtaining in either the sharks or the rays. Although well nigh extinct, these enamel-scaled fishes are still represented by the bony pike of the rivers of North America, and the bichir (remarkable for its fringed fins and the row of finlets down its back) of tropical Africa. But it is noteworthy that in neither of these survivors of an ancient group do we find the mouth furnished with an apparatus of millstones; while, as already said, among the host of sharks that infest the warmer seas of the globe it is only in the Port Jackson species and its three kindred that we find similar structures retained; all the other members of the group having developed cuspidate teeth adapted for seizing and tearing soft-fleshed prey, instead of for grinding up mail-clad food.

Clearly, then, there has been some general cause at work which has rendered crushing teeth, so to speak, unfashionable among the fishes of the present day and the immediately antecedent epochs. And in this connection it is important to notice that there has been an even more strongly marked tendency to the extinction of the enamel-scaled fishes, and their replace-

ment by the ordinary soft-scaled fishes so abundant in the present seas. As the majority of these old mail-clad fishes, as well as a large proportion of the ancient sharks were provided with crushing teeth, it is a fair inference that their food consisted largely of shell-fish and crustaceans with a certain proportion of their own mail-clad relatives. When, however, the swift-swimming soft-scaled fishes came to the fore, they would naturally offer a more tempting and nourishing diet to such sharks and other predaceous members of their own class as were swift enough in their movements to make them their prey. And consequently the old millstone-jawed sharks would tend to more or less completely disappear. On the other hand, the skates and rays, which are for the most part slow-moving creatures, flapping sluggishly along on the sea-bottom by means of their fan-like fins, would be quite unable to capture the modern type of swift-swimming fish. And they have thus had to content themselves with the old-fashioned diet of shell-fish and crabs, in consequence of which a large proportion of them have retained the dental millstones which have been so steadily going out of fashion among their more advanced relatives. Not that these rays and skates have by any means been content with the kind of molar machinery that did duty for their forefathers, since some of them, together with their Tertiary ancestors, have developed what appears to be an absolutely perfect type of living mill, far superior to that which served the purpose of their predecessors. And it must always be remembered that these beautiful living millstones and cylinders (which are some of the most exquisite bony structures to be met with in the whole animal kingdom) excel their artificial substitutes in that they never wear out; being renewed either by the development of new teeth on the inner or hinder aspect of the cylinder, or by vertical successors replacing the individual teeth from below or above.

And now that the dental millstones of the rays have been mentioned, it will afford a convenient starting-point for a brief survey of some of the most remarkable types of structure presented by these curious organs.

The teeth of rays always form a pavement-like



4. 5.

FIG. 4.—Upper Teeth of Beaked Ray (*Rhynchobatis*).

FIG. 5.—Part of the Palate of *Lepidotus*, an Enamel-scaled Fish from the Wealden.

structure, of which the component elements are arranged in straight longitudinal rows, although (Fig. 4) they may likewise show a quincunxial mode of arrangement. The individual teeth are not replaced by vertical successors; but, being in the form of a half-cylinder, as those in front become worn down, the whole series is pushed forwards, and new teeth are developed on the hinder margin of the cylinder. The supreme development of a dental structure adapted for crushing in this group occurs in the family of the eagle-rays (*Myliobatidæ*), in which the millstone (Fig. 1) of each jaw forms a perfect semi-cylinder or plate, made up of flat-crowned prismatic teeth united at their edges, often so as to constitute a mosaic-like pavement. No piece of modern machinery can be better adapted for crushing hard substances than are these beautiful ivory cylinders and plates, the crushing power of which, when worked by the strong jaws, must be enormous, and sufficient to grind the strongest shell that can be introduced between them to powder. Although in all cases pavement-like, the millstone differs considerably in the different species in its structure. As an illustration of the group we may take one of the millstones of the beaked eagle-rays (*Rhinoptera*), shown in Fig. 1. Here the millstone is in the form of a semi-cylinder, consisting of five or more rows of teeth; a very usual number being seven. Generally (as in the figure) the teeth of the middle row are the widest; those of the rows on either side being considerably narrower, while the two or three marginal rows on each side may be compared to the tessaræ in a mosaic pavement. A further development of the same type is exemplified by the typical eagle-rays (*Myliobatis*), in which the middle row of teeth in the millstone becomes still wider, while the three lateral rows on each side are reduced to the condition of hexagonal tessaræ. Moreover, whereas in the species of *Rhinobatis* both millstones are in the form of half-cylinders, in *Myliobatis* the upper one alone retains this form, the lower being a flattened plate. The culmination of this type of structure is displayed in the rays belonging to the allied genus *Aëtobatis*, in which both upper and lower millstones are flat and composed only of the middle row of teeth, which are of great width; the lateral rows having completely disappeared. The existing representative of this genus is not very large (for a ray), seldom if ever measuring more than about five feet across; but some of its extinct predecessors must have been monstrous fish, as the teeth measure five or six inches in diameter.

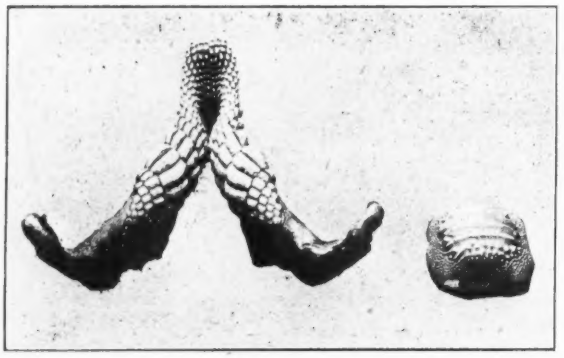
Quite a different type of dental armature is presented by the millstones of the beaked rays (*Rhinobatidæ*), of which a specimen from the upper jaw of a species belonging to the genus *Rhynchobatis* is shown in Fig. 4. Here the teeth take the form of closely packed diamond-shaped knobs, arranged in an alternating manner, so that although they present longitudinal rows, yet they also show oblique series, so as to give rise to a quincunxial pattern. Then, again, the entire millstone in each jaw is thrown into a series of undulations, so that the upper one, as in the figure, exhibits a large median boss, flanked by a pair of smaller undulations, which are received into corresponding depressions in the lower millstone. It is difficult to conceive a machine better adapted for crushing than is presented by the jaws of the beaked rays.

Of a much less powerful type are the millstones of the ordinary rays or skates (*Raiidæ*) of our own coasts; and among these the common thornback (*Raia clavata*) presents a very remarkable condition, since the individual teeth take the form of obtuse knobs in the female, whereas in the male the centre of each of these knobs acquires a sharp recurved point. Since every thing in nature has a meaning, it would seem a fair inference that there must be some important difference between the food of the male and female thornback, but I have not come across any observations bearing upon the subject.

XUM

Among the fossils to be obtained occasionally from the workmen in large chalk-pits are teeth of the type shown in Fig. 7; the specimen depicted having been purchased by myself in a pit near the road between Chatham and Maidstone. As many others were offered at the same time, it doubtless formed part of a more or less complete millstone, which, as is too often the case, was broken up by the workmen. These teeth form convex quadrangular bosses, the marginal portion of which consists of a broad granular area, while the centre is occupied by a variable number of bold ridges, or folds, between which are often irregular knobs. It is from these ridges that the fish take the name of *Ptychodus*. For a long time it was uncertain how these teeth were arranged, but careful comparison of a number of more or less incomplete series *in situ* has at length solved the problem. In the lower jaw the complete millstone was formed by a median row of large teeth similar to the one figured, on each side of which were six or seven other rows composed of teeth gradually decreasing in size from the centre to the margin. In the upper jaw, on the other hand, there was a central row of small teeth, flanked on each side by a row of large ones, externally to which came a series of rows gradually diminishing in size. From this mode of arrangement it is inferred that *Ptychodus* was a ray; and the whole dental structure is as remarkable for its perfection as a crushing machine as it is for its intrinsic beauty.

Even more elegant from an æsthetic point of view are the "millstones" of the Port Jackson shark (*Cestracion*) and its allies; the upper jaw of the Australian species being shown in Fig. 6. In place of forming a continuous plate across the palate after the fashion of the eagle-rays, the individual teeth in this group are arranged in oblique bands round the edges and inner sides of the jaws,* showing in the hinder region a melon-shaped swelling of remarkable gracefulness, which would form an attractive ornament for the capital of a pillar. In this melon-like portion



6. 7.

Fig. 6.—Upper Dentition of the Port Jackson Shark (*Cestracion*).
Fig. 7.—A Tooth of the Ridge-toothed Ray (*Ptychodus*).

of the millstone the individual teeth form bluntly convex oblongs; those of one row being markedly larger than all the rest, while the rows in front of and behind this do not correspond with one another in size. Examined with a lens, each of these blunt teeth is seen to have a minutely pitted structure, while its median longitudinal line is marked by a narrow smooth streak. New teeth are being continuously produced on the margin of the series on the inner side of the jaw, and as the outer ones become worn away, the whole series is pushed over towards the edge of the jaw. Proceeding from the larger rows of teeth towards the front of the jaw, it will be seen that as the individual teeth become gradually shorter their smooth median line gains prominence, till it finally develops into the sharply pointed cusp surmounting each of the front teeth.

As already said, the Port Jackson shark and a few other nearly related species (all of which, by the way, feed on shell-fish and crustaceans) are the only sharks with millstones met with in our present seas. And it is fortunate that these have lived on, as otherwise we should never have gained a true idea of the dental armature of their extinct relatives which abounded in the seas of the Jurassic epoch. Visitors to Whitby must be familiar with certain black oblong fossils of about an inch and a half in length known to the quarrymen as "fossil leaches." These are the hinder teeth of an extinct shark (*Asteracanthus*) nearly allied to the Port Jackson species, but of much larger size; and although they are more rugose than pitted, they show the same smooth line on the summit. A beautiful specimen from Caen, in the British Museum, shows that the arrangement of these hinder teeth was almost exactly the same as in *Cestracion*, which may thus be regarded as a survivor from a long past epoch of the earth's history.

But there were other "millstone-mouthed" sharks at a still earlier period which appear to have been allied to *Cestracion*, although the degree of relationship is uncertain. In these Palæozoic sharks, as exemplified by *Cochliodus*, of which the imperfect millstones are shown in Fig. 2, the series of hinder teeth seem to have had an arrangement very similar to that obtaining in *Cestracion*, but the individual teeth of several series were more or less completely fused into a single solid plate, the ridges on which mark the original lines of division between the component series. These sharks exhibit, therefore, one among many instances where the earlier forms of a group are in some respects more specialised than their descendants.

So much space has been taken up by the rays and sharks that only a few lines remain for the millstones of the enamel-scaled fishes. In none of these do the teeth, which are developed on most of the bones of both the upper and lower jaws, ever form continuous plates; and they are generally either spherical (Fig. 5) or kidney-bean-shaped (Fig. 3), and arranged in more or less distinct longitudinal rows. Unlike those of the sharks and rays, these teeth, as in the familiar *Lepidotus* of the Wealden (Fig. 5), are replaced by vertical successors; and their mode of development is so peculiar that in some cases the new tooth is placed wrong way up beneath the one it is destined to replace. In other instances, as in *Cœlodus* (Fig. 3), from the Folkestone Gault, successional teeth have not been observed, and the mode of renewal is consequently still unknown. Although within the limits of a single article in Knowledge it is impossible to do more than give the crudest sketch of a vast subject, yet what has been written may be sufficient to attract my readers' interest to an extremely fascinating branch of zoological study.

* Strictly speaking, the tooth-bearing cartilages of sharks are not true jaws.

MRS. QUICKLY'S "TABLE OF GREEN FIELDS."

By the Rev. D. R. FOTHERINGHAM, M.A. (CANTAB.).

ONE of the pleasures of life in a remote Highland village is to take down my old volumes of KNOWLEDGE, and turn over the sparkling pages of Mr. Proctor's conductorship. While occupied thus a short time ago, my attention was struck by an article bearing the pseudonym of Malvolio, and dealing with the text of Shakspere. An inexhaustible subject truly! For whether it be true or not that the fluent bard scarce effaced a line, yet the critics and commentators of three centuries have done their worst, effacing, blotting, blurring, adding, correcting, altering, spoiling, until in many cases the original text seems to be hopelessly lost beneath the load of conjectural emendation. True lovers of English literature cannot but protest against this treatment of the poet's work, and there is a growing desire among them to return to the original folio editions of the plays, rather than yield further acceptance to the corruptions introduced by successive editors.

That the folio text of Shakspere is sometimes incorrect and requires emendation may be readily granted; but it is unhappily true that many alterations have been made in pure wantonness of spirit, and have no justification whatever. One may recollect, for instance, how Hamlet is addressed by the courtier Osric as "your friendship." Osric is a Euphuist, and delights in the use of strange and affected language. But when the clumsy pen of an undiscerning editor has altered "friendship" to "lordship," poor Osric's character is gone for ever, and he is nothing more than a commonplace young man, who might almost be mistaken for sensible.

An instance of still worse emendation might be cited from Julius Cæsar. It will be remembered that before his assassination the conspirators approach him with a petition, and each of them kneels in order to present it, Cæsar protesting the while and bidding them rise. Cinna falling at his feet is repulsed with "Hence! wilt thou lift up Olympus?" Immediately afterwards Decius Brutus kneels, and is more kindly met with, "Do not, Brutus, bootless kneel." All this is simple enough. It happens, however, that there is another Brutus on the stage, the famous Marcus Brutus, and there is no direction to indicate whether he is kneeling or not, though the previous language makes it probable that he is. Editors, however, have generally supposed him to be still standing, and taking Cæsar's words as addressed to him (very absurdly, one cannot help thinking), they have ventured to alter "do" into "doth," and to add a mark of interrogation at the end. It will surely be agreed that in this case there is no need for any alteration whatever, and that the alteration actually made is vastly inferior to the original reading of the folio.

These two instances have been deliberately chosen from many hundreds, as representing different classes of passages to which conjecture has been applied. In the one case Osric's own language, like Mrs. Malaprop's, tempts us to correct him: though only a dull wit should yield to such temptation. But the other is an example of editorial licentiousness that cannot be too strongly condemned.

But the most famous of all critical conjectures applied to the text of Shakspere is Theobald's correction of the hostess' language (she is known to us as Mrs. Quickly, though now married to Pistol) in describing the death of Sir John Falstaff. The folio reads:—

> After I saw him fumble with the sheets and play with flowers and smile upon his finger's end, I knew there was but one way; for his nose was as sharp as a pen and a table of green fields. "How now, Sir John!" quoth I, &c. (King Henry the Fifth, II. 3).

The reading is sufficiently surprising as it stands. That Falstaff's nose might look as pointed as a pen is not impossible. Indeed, such a sharpening of the nose was then looked for as a sign of approaching death. But the table of green fields is too outrageous a comparison, even for Hostess Quickly. Here, if ever, is a case where conjecture seems legitimate, or even necessary, and one editor at least has risen to the occasion with a poetical instinct that is far from common among critics generally.

Let us deal with the bad alterations first. In Staunton's opinion they need only be mentioned to be laughed at. But at all events Mrs. Quickly (or Pistol) is a comic character, and laughter will not be out of place. For "and a table of green fields," then we are invited respectively to read "in a table of green fields," "on a table of green frieze," and "or as stubble on shorn fields." Only the last of these makes any improvement in the simile, but the conjecture is too bold to have a place in legitimate criticism. Even bolder, however, was Pope's treatment of the passage, and it is right to give it in his own words: "A table was here directed to be brought in, and this direction crept into the text from the margin. Greenfield was the name of the property man in that time who furnished implements for the actors. A table of Greenfield's." Pope's suggestion must stand or fall by its own merits, for comment is superfluous.

Better, however, is forthcoming. These suggestions may be left to speak for themselves and provide merriment for Staunton's followers, while we pass on to the conjecture now generally received. Some unknown gentleman in the early part of the seventeenth century had altered "table" to "talked," and left a manuscript note in the margin of his Shakspere. This note caught Theobald's eye, and with admirable instinct he corrected "talked" to "babbled," thus reading "and a' babbled of green fields." We thus get a complete and beautiful picture of Sir John's last moments, and may well feel pity for the poor knight, fumbling with the sheets, playing with flowers, smiling on his finger's end, while his thoughts turned from that sordid Eastcheap inn to the far off country "and a' babbled of green fields."

The trouble is that the emendation is a great deal too poetical. It is not in keeping with Mistress Quickly's character, however much that character may have been etherealized by Pistol's companionship. We have not to deal with Sir John's "finer end" so much as with her recollection and description of it; and even if the knight's thoughts had been sufficiently purified by the approach of death to take delight in rustic scenes, she was hardly the woman to notice it. She was kindly enough in her way, and could "lay more clothes on his feet" when he wanted them, or call in his friends to witness his burning "quotidian tertian," or essay to comfort him (knowing him to be at the point of death) by bidding him "not think of God, for there was no need to trouble himself with any such thoughts yet." Her religious character is further manifested by the reflection that Sir John is now in Arthur's bosom, and that the incarnation of devils would give them an objectionable colour. She remembers too that he was rheumatic (accent on the first syllable), and, therefore, unaccountable for his words, and that he cried out of sack, and talked of the whore of Babylon. But she is

XUM

entirely lacking in finer appreciations. Indeed it is very questionable whether there was anything very fine to appreciate. If Falstaff cried out of sack, and of women, of devils, the whore of Babylon, and the flea on Bardolph's nose that reminded him of a black soul in hell-fire, his conscience may have been troubling him sorely enough, but it may be doubted whether his thoughts ever ran on rustic scenes of Nature in her purity and grace. Certainly if they did, the hostess would dismiss them as "rheumatic" again, and they would never be retained in her dull and prosaic mind.

It is to be feared then that Theobald's conjecture, beautiful as it is, must be abandoned, and as the same fate has befallen every other conjecture, we are forced back upon the text of the folios. Is it possible to make sense of this? The question is well worth answering: for if we can make sense of the original, the need for emendation disappears at once, and every conjecture, good or bad, must fall to the ground.

"His nose was as sharp as a pen and a table of green fields" has been supposed to mean that his nose had a pointed look and was covered with spots. But this seems to be forcing the language. Besides green is hardly the colour one would expect on Falstaff's nose, whether in spots or otherwise. A much better plan seems to be to take the clause, "For his nose was as sharp as a pen" as parenthetical. The sentence then reads, "I knew there was but one way (for his nose was as sharp as a pen) and a table of green fields." Sir John had only one more road to go, and that was the road to the churchyard, ending amid the little green mounds that are scattered over God's acre.

This suggestion is offered with a good deal of diffidence; yet haply it may do something to clear up an admittedly difficult reading.

NOTES.

ASTRONOMICAL.—Professors Liveing and Dewar have obtained evidence of the possible existence in our atmosphere of the chief gases which are luminous in the solar corona and in nebulæ. After freezing out the more condensable gases, such as argon, nitrogen, and oxygen, by exposing the mixture of gases to the temperature of liquid hydrogen, the spectrum of the residue was found to contain lines of hydrogen, helium, and neon, together with certain unknown lines. Among the latter were several weak lines which seem to correspond with the principal lines in Sir Norman Lockyer's list of coronal radiations, and in one experiment a line was obtained which falls very near to the chief nebular line in the green. The experiments also conclusively demonstrate the existence of free hydrogen in our atmosphere.

The approaching opposition of Mars has already brought a crop of sensational newspaper paragraphs. Early in December, Mr. Douglass, of the Lowell Observatory, announced the observation of a projection on the northern edge of the Icarium Mare, which remained visible for seventy minutes. In newspaper language: "A series of bright lights suddenly appeared in a straight line extending for several hundred kilometres." In its exaggerated form the observation of course suggests a message from the Martians, but the actual observation is by no means so conclusive.—A. F.

BOTANICAL.—The Grasswrack *(Zostera marina)*, a common plant of sandy or muddy places near the sea in Britain and other temperate countries, has been discovered by Captain Deasy in the Kuen Lun Mountains, Tibet, at an elevation of 16,500 feet. Specimens collected in this extraordinary situation were exhibited by Dr. A. B. Rendle at a recent meeting of the Linnean Society. They were not growing when discovered, but were preserved in what is believed to have been the bed of a salt lake. Though dry and brittle, a microscopic examination revealed an internal structure as perfect as that of living specimens. This species has never previously been found in an inland lake, though the Dwarf Grasswrack *(Z. nana)* is known from the Caspian Sea. In the *Journal of Botany* for January we are informed that a paper on Captain Deasy's interesting discovery will shortly appear in that publication.

Primula obconica, since its introduction into our gardens twenty years ago, has been the subject of considerable attention, both on account of its wonderfully floriferous character and poisonous properties. Instances of skin irritation, sometimes of a very violent nature, caused by handling the plant, have been recorded from time to time in the *Garden and Forest*, the *Gardeners' Chronicle*, and other journals. A valuable contribution to the literature concerning this *Primula* has been supplied by Herr A. Nestler in the *Berichte der deutschen botanischen Gesellschaft* for 1900. The author gives the results of a series of experiments which he conducted with the view of ascertaining what part of the plant produces the irritation. He found that water, which collected on the margins of the leaves when the plant was placed in a moist room, or juice, which he expressed from the leaves and flower stalks, had no effect. A young umbel applied to the wrist by an elastic band for two hours proved almost harmless; but a piece from the base of a leaf-stalk applied in the same way for two hours produced acute irritation with blisters and swelling of the arm. Herr Nestler shows that it is the yellowish-green matter in the glandular hairs which possesses the poisonous properties.—S. A. S.

ENTOMOLOGICAL.—The "driver" ants of America and Africa are well known to readers of the works of Belt and other travellers in the tropics. For a long time the "worker" ants included under this designation could not be referred to the same species as any known forms of developed females or males. Dr. Sharp, in the "Cambridge Natural History" (Vol. VI., pp. 174f.), gave a summary of recent researches which have established the remarkable fact that the developed forms of several African species of "driver" ants had long been known to naturalists under distinct generic titles, so marked is the divergence between the forms in these insects. Quite lately Prof. W. M. Wheeler describes (*American Naturalist*, XXXIV., 1900, pp. 563-574) the hitherto unknown female of *Eciton*, the American genus of driver ants (the male had already been described under a different generic name). These females are, like the workers, wingless, but they differ most remarkably in size and form, being four times as large, and having only one "nodal" segment in the hind body. The workers have two, and this character of the "nodal" segments is a leading one in discriminating the subfamilies of ants; here, however, it varies in the same

sex of the same species! The female *Eciton* has a swollen hind-body like that of a young "queen" termite, and lays a vast number of eggs. She is often covered with a multitude of parasitic mites. Prof. Wheeler gives some interesting details of rove-beetles found in the nests of *Eciton*. His observations confirm the results obtained by Wasmann who noticed that the "guest"-beetles in the nests of these ants resemble their hosts closely in form and sculpture, but often differ in colour. The ants being blind, the "mimicry" of the beetles is thought to deceive their sense of touch, it being needless to deceive a non-existent colour-sense.—G. H. C.

ZOOLOGICAL.—At a recent meeting of the Zoological Society the secretary exhibited two strips of the skin of a zebra, sent by Sir Harry Johnston, from the Semleki River, near the border of the Uganda Protectorate. These appear to indicate an entirely unknown representative of the group.

Judging from the report of Mr. W. Garstang, published in the November issue of the *Journal* of the Marine Biological Association of the United Kingdom, the swarms of octopus which have recently appeared on both sides of the British Channel are inflicting untold harm on the crab, lobster, and oyster fisheries. The increase in the numbers of this comparatively scarce cephalopod was first noticed in the spring of 1899, since which date the creatures have appeared in such hosts as to justify the application of the term "plague" to the visitation. The quantity of shell-fish destroyed by these voracious cephalopods is almost incredible. Fortunately the octopus itself is not difficult to capture, and a fisherman can easily account for more than half a hundred per week in the course of his work. On the French coast they are taken and sold for food; and the quantities caught on the two sides of the Channel ought to have some appreciable effect on the numbers of the pest.

The third series of reports to the Malaria Committee of the Royal Society has just been issued, and contains the results of observations made by Drs. Stephens and Christophers on the west coast of Africa, and by Dr. Daniels in East Africa. The two former writers urge that it cannot be too clearly realised by Europeans living in the large towns of West Africa that they are dwelling amidst thousands of cases of malaria none the less dangerous from the fact that the native children suffering from the disease do not exhibit the usual signs of fever. "Malaria is essentially a contagious disease, the contagion being conveyed by the mosquito; the laity must appreciate this fact and refuse to dwell in the midst of contagion, they must recognise that malarial fever is a contagious disease contracted (through the medium of the mosquito) from the native child. Malarial fever, we are convinced, can be avoided most readily by avoiding the cause of contagion, and living as far removed as possible from native huts. . . . The adult native possesses an active immunity against malaria, and though living under the same condition as the children, constantly subject to the bites of infected *Anopheles*, yet examination of his blood shows that parasites are always absent."

The latest issue of the *Geographical Journal* contains a most interesting account of the results of Mr. Moore's recent expedition to Lake Tanganyika and the regions to the northward. Mr. Moore brings forward additional arguments in favour of the marine origin of the fauna of this lake (which includes shells of a marine type and a jelly fish); and from the absence of a similar assemblage of animals in the more northern lakes, he is led to conclude that Tanganyika communicated with the ocean by way of the Congo basin, and not through the Nile valley.

In the November issue of the *Communications* of the Millport Marine Biological Station, Dr. Gemmill endeavours to ascertain whether limpets and mussels living in the higher tidal zones support the theory that inferior nutrition tends to the development of a preponderence of females. In these molluscs the sexes are not differentiated until some time after the free-swimming stage has been abandoned; and since the individuals left dry only at very low tide are, owing to longer opportunities for feeding, generally superior in size to those living in a higher zone, they ought to confirm the theory, if it be true in all classes of animals. No preponderance of males was, however, observable in the low-tide individuals.

CONSTELLATION STUDIES.

By E. WALTER MAUNDER, F.R.A.S.

No. II.—THE REGION OF LEO.

THE February nights bring to the meridian the most famous of all the constellations of the Zodiac; the constellation, that is to say, of the Lion. Its primacy is beyond question due to the fact that the place of the sun at the summer solstice was in this constellation at the time when they were first devised, and no doubt its brightest star derived its name, Regulus, or "little king," as being the chief star of the paramount sign. Both names are traditional in many different countries; the constellation is the Latin Leo, the Hellenic Λεων, the Persian Shir, the Hebrew Aryeh, and the Babylonian Aru, all alike meaning "Lion"; whilst our present name for the star is the variant, proposed by Copernicus, for the older Latin Rex. Ptolemy calls it βασιλισκός, the Arabs give it Malikiyy, the "kingly" star, and the cuneiform inscriptions of the Euphratean valley refer to it as the "star of the king," whilst in ancient Persia it was the chief of the four "royal stars." It is its place, however, and not its brilliance, which has gained for Regulus this distinction, for almost all the first magnitude stars are its superiors in brightness.

The constellation of the Lion is very easily found when the Great Bear is known.

> "Neath her hind feet, as rushing on his prey
> The lordly Lion greets the lord of day."

The Great Bear at this season at midnight is at its greatest elevation, and below it towards the south, we find the Lion. The stars in it are formed into two principal groups. The Sickle, six bright stars marking the animal's head and breast, whilst a Rectangle indicates its hinderquarters. A line from Alpha in the Great Bear through the third foot, that marked by Lambda and Mu, and prolonged beyond the foot to an equal distance, brings us to the centre of the blade of the Sickle, whilst another line from Gamma through the fourth foot leads to the Rectangle.

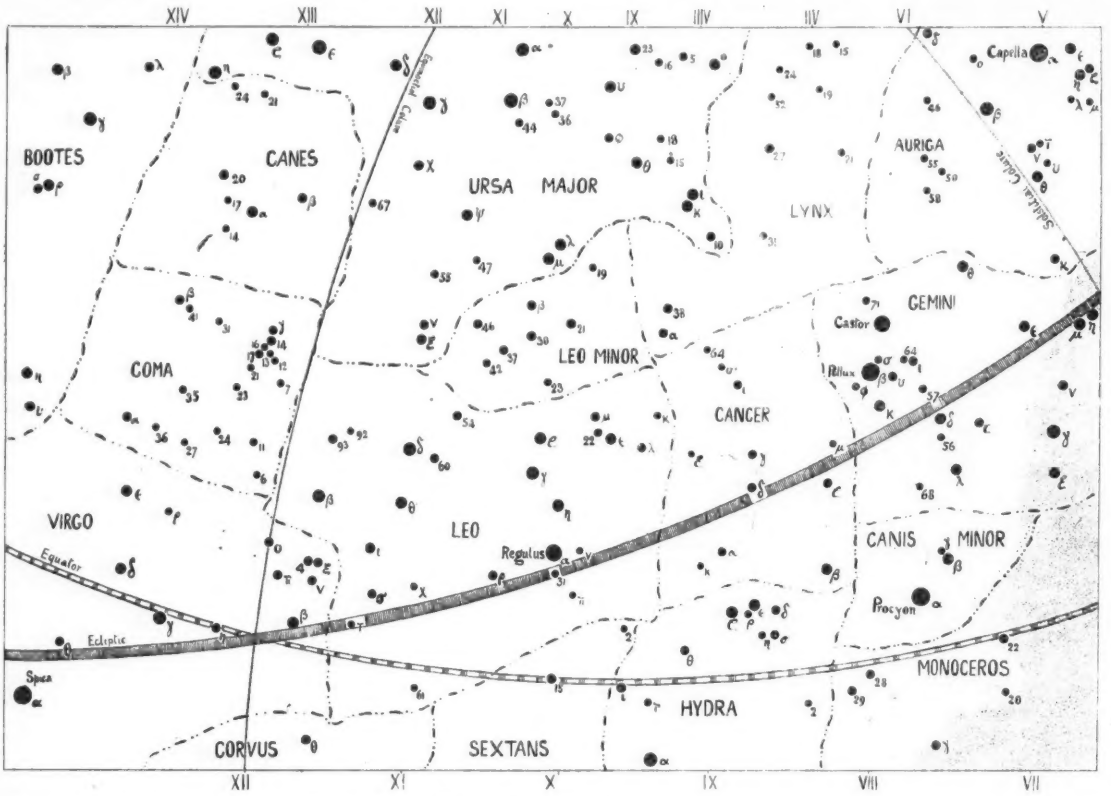
The stars of the Sickle, beginning with the most westerly, run in the following order, Epsilon, Mu, Zeta, Gamma, Eta, Alpha. In the very centre of the trapezium made by the first four of these, is the place of the radiant of the celebrated Leonid shower of meteors, the showers which gave us such splendid displays in 1833 and 1866, and to which in truth we owe our knowledge of meteoric astronomy, since they first drew real scientific attention to the subject of meteors and afforded the means of solving many of the problems which they present.

The fourth star Gamma is but little inferior to Regulus in brightness, and in a telescope it is an extremely

interesting and beautiful double star. It bears the Arabic name Algieba, meaning "Forehead," though it is actually situated on the Lion's breast. It forms a fine contrast in colour to Regulus, being distinctly deep yellow, whilst the latter is white. Gamma, Zeta and Epsilon are all interesting as opera-glass objects from the companions which a slight optical assistance brings into view.

Leaving the Sickle, we come to the Rectangle, the four stars marking which are of very different magnitudes. Delta and Theta mark the western side; 93 and Beta the eastern; of these Beta is much the brightest, Delta following next. Beta is Denebola,—one of the many Denebs, that is "Tail," which we find in the sky,—and from its companion stars, forms an interesting opera-glass field. Cancer is the smallest and least conspicuous of all the constellations of the ancient names, but there are some slight variations in the figure ascribed to the entire constellation, the Egyptians tracing here a scarabaeus, and some of the mediæval astronomers representing it by a lobster or crayfish.

Passing on further to the west, a pair of bright stars are seen as far below the forefoot of the Great Bear as Alpha is above it. These are Castor and Pollux, the two chief stars of the constellation Gemini, the "Twins." This constellation is, according to Brown, a stellar representation of the great Twin Brethren of the sky, the sun and the moon, who join in building a mysterious city and who are hostile to each other although they work together. In classical legend they are the children of Zeus and Leda, the Dioskouroi, and by no means have the fraticidal relation which this interpretation would suggest. The idea of strife between sun and moon



Star Map No. 2; The Region of Leo.

Zodiac. Its most significant feature is found in the centre of the group; a pair of stars between the fourth and fifth magnitude, Gamma and Delta, north and south respectively of a misty looking object. These are the twin "Asses," standing right and left of their "Manger," Praesepe.

> "Like a little mist,
> Far north in Cancer's territory it floats.
> Its confines are two faintly glimmering stars;
> These are two Asses that a Manger parts."

Many a young beginner has fancied that in Praesepe he has discovered a new naked eye comet, but the least optical aid shows it to be a cluster of small stars, and directly Galileo turned his telescope upon it, he detected its nature, counting some thirty stars within its borders. The Asses and the Manger appear to be

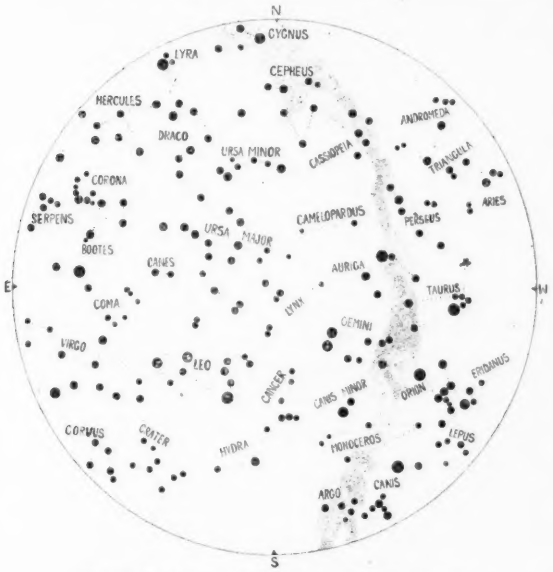
is natural enough, and no doubt many stories like that of Romulus and Remus took their form from such a nature myth. But the idea of strife is not the leading one in most of the legends relating to the stars Castor and Pollux, who are indeed shown as man and woman on many zodiacs, and I think that this fact renders it questionable if it is safe to press far the considerable doubt on the root idea of Mr. Brown's theory that the ancients, so to speak, solarized the stars, designing the constellations to perpetuate the stories in which they had dramatized their conceptions of solar and lunar relations.

The limits of the constellation are easy to trace out. Four fairly bright stars, nearly in a straight line, mark the feet of the Twins, whilst Castor and Pollux mark

their heads. They are standing in fact upon the Milky Way. The four feet stars are Mu, Nu, Gamma, and Xi. Close by Mu is Eta, another star in the foot of Castor, and in the neighbourhood of these two stars is a splendid cluster, 35 Messier, which is just visible to the naked eye, but which well repays examination with the opera-glass. Castor is one of the most celebrated of double stars, though of course altogether beyond the grasp of an opera-glass as the components are not 6" apart, but the constellation as a whole is a fine one for examination with the opera-glass, especially in the region of the Milky Way. The contrast in colour between the two principal stars, Castor and Pollux, is noticeable enough even with the naked eye, but becomes very striking when the glass is turned upon them. Gemini forms the home of several important meteor-radiants, especially that of December 10 to 12.

Between Leo and Ursa Major is a modern constellation, called Leo Minor, framed by Hevelius out of the unformed stars which he found in this region. Its components none of them exceed the fourth rank, and it is chiefly noticeable to the naked eye astronomer as the home of a meteor radiant of the second rank.

The Lynx, lying between Ursa Major and Cancer, is



The Midnight Sky for London, 1901, February 5.

an even fainter constellation than Leo Minor; its two principal stars Alpha and 38 make a visual pair, very similar to the three that have already been noted as marking the plantigrade feet of Ursa Major, and as Prof. Young has suggested, they might well have been taken to have made up the fourth, though, had this been so, our Bear would have been a "high-stepper" of most un-ursine agility.

Underneath the three stars which make the handle of the Plough, or tail of the Bear, is a bright star, easily recognized from the comparative bareness of the region in which it is placed, which is known as Cor Caroli, "Charles' Heart," so called because Sir C. Scarborough declared that it shone with peculiar brightness the night before Charles the Second made his entry into London on his restoration. This name, however, attaches only to the single star; the constellation like Lynx and Leo Minor, being one of those which we owe to the ingenuity of Hevelius, who named it Canes Venatici, the "hunting dogs." Cor Caroli is a beautiful double star, the components of which are about 20" apart.

Below Canes Venatici, and immediately to the east of the rectangle of Leo, is a constellation which, though ancient, is by no means one of the original ones. Though it possesses no bright stars, yet on a clear night the region will attract the attention of the sharp-sighted observer, for delicate points and films of light are crowded in it. Serviss writes of it:—

"You will perceive a curious twinkling as if gossamer spangled with dewdrops were entangled there. One might think the old woman of the nursery rhyme, who went to sweep the cobwebs out of the sky, had skipped this corner, or else that its delicate beauty had preserved it even from her housewifely instincts."

The story of its naming is that Berenice, the Queen and sister of Ptolemy Euergetes, vowed her beautiful hair to Aphrodite, should her consort return safely from an expedition on which he had set out. The consecrated tress was, however, stolen from the temple soon after its dedication, and the consequences might have been very serious had not the royal astronomer of Alexandria, Conon, risen to the occasion, by declaring that Aphrodite had caught the tress up to heaven, in proof whereof he pointed out the constellation to the king and queen. Probably, however, the stars in this region had already a half-recognised position as forming a separate constellation, and the quick wit of the astronomer but confirmed a brevet rank.

CONSTELLATION-FIGURES AS GREEK COIN-TYPES.

By ROBERT BROWN, JUNR., F.S.A.

THAT nearly the whole of our ancient constellation-figures are to be found as types on coins will be admitted by anyone who is familiar with the subject. But of course the question for consideration is, Do they so appear *as* constellation-figures? A numismatic Ram has no necessary connection with the zodiacal *Aries*. We should require very strong evidence to show that a flaming Altar contained a reference to any constellational *Ara*, and so on. Here, as elsewhere, everything is a matter of evidence; nothing must be assumed, everything is possible. The next step to be noted in the enquiry is that various constellation-figures, *e.g.*, the Signs of the Zodiac, have undoubtedly appeared, as such, on coins. The twelve Signs are to be found on coins of the Roman Empire, as on coins of the Emperor Jahângîr,[1] the *Capricorn*, as the fortunate Sign of Augustus, being specially prominent. Then, turning to the earlier Greek coins, we find that all over Hellas, from Italy to Pontus, constellation-figures appear as coin-types in astonishing numbers and with the greatest persistency. Do they, then, here appear in some cases as constellations? So far, this would seem to be by no means improbable. But several general theories of the origin of coin-types, exclusive of any astronomical connection, have been suggested. Thus, it is said that man put on his coins what he saw around him. He saw a lion, a lion tearing an ox, etc., and stamped representations of these on his coinage. Yes, but he did not see a gryphon, or a Pegasus, or a naked man with a club and lion-skin fighting against a many-headed snake and a crab. So we see that this theory will not enable us to explain either constellation-figures or coin-types as a

[1] Vide E. W. Maunder, *The Zodiacal Coins of the Emperor Jahângîr* *Knowledge*, July 1, 1899).

whole. Again, it is said that man stamped on his coins images of trade and barter, *e.g.*, sheep, oxen, goats, the *silphium* plant, and so on. But, I fear that if we attempt any general explanation of ancient coin-types on this principle we shall be landed in great difficulties. We cannot admit a trade in gryphons and man-headed bulls, in serpents, scorpions or eagles. We shall find on early coins-types, as elsewhere, symbolism and imitation; and if heaven can help us to understand them in some degree, let us not disdain its assistance.

The use of constellation-figures as coin-types has been treated of, to some extent, by M. Svoronos and Prof. D'Arcy Thompson, and also by myself in a recent work.[2] But what has been said is mainly preliminary, and the subject is still almost virgin ground. I propose to illustrate it here by a few examples; and, before referring to these in detail, would observe that I follow the descriptions of the subjects of the coins given by the British Museum experts. I would also remind the reader that nearly the whole of the forty-eight ancient constellation-figures of the Greeks were borrowed by them from their Eastern neighbours; and that very many of these figures appear as constellations in the literature and art of the Euphrates Valley.[3] Turning, then, to the particular examples before us, we find[4]:—

No. 1. *Herakles kneeling.* 'Herakles bearded, naked, kneeling on one knee, r.' With club, strung bow and two arrows: behind, Tunny. Cyzicus. Cir. B.C. 500—450. Every Sign of the Zodiac, except *Aquarius*, and other constellation-figures, whether as such or not, appear on the coins of this city, which, through Miletus and Lampsacus, is connected with Crete and Ph. influence. We know from Panyasis of Halicarnassus (ob. cir. B.C. 457), that the constellation which Aratus calls the *Kneeler* (*Engonasin*), was called *Herakles*=Ph. *Harekhal* ('the Traveller'). Amongst the names of this constellation are *Melicartus* (=Gk. *Melekertes*, Ph. *Melqârth*, 'King-of-the-City'), *Malica* (=Ph. *Melekh*, 'the King'), *Palemon* (=Gk. *Palaimon*, Ph. *Baal-Hamon*, 'the Burning-lord'), and *Maceris* (=*Makar*=*Melqârth*). A good instance of the type is the fine kneeling Herakles of the Ph. Thasos;[5] but the prototype is the Euphratean Gilgamesh (Gk. Gilgamos, Aelian, xii. 21), the 'giant-king,' who so frequently appears in Euphratean art bearded and kneeling on one knee, contending with a Lion, whose skin, in Hellas, he, as Herakles, wears or carries. In *Tab. No.* 83—1—18,608 'the constellation of the *King*' (Sumero-Akkadian *Mul Lugal*, Bab.-Assyrian *Kakkab-Šarru*) appears above 'the constellation of the *Scorpion*,' as on our own Globe.

No. 2. *Herakles with Hydra and Crab.* 'Herakles striking with club held in r. hand at Hydra which rears up before him, and whose nearest head he grasps with his l. hand; at his feet crab; over his l. arm, lion's skin.' Phaestus. Cir. B.C. 431-300. The story of the fight is told by Apollodôrus (II. v. 2). A great scholar once said to me that if I had tried to invent a tale to support my view, I could not have hit on anything so perfect. According to Pausanias (II. vi. 3), Phaestus was a son of Herakles who taught the people of Sicyon to sacrifice to his sire, not as a hero but as a god (Ib. x. 1). Here we note the introduction of the cult of a foreign divinity. The *Hydra*, *Crab*, *Lion* and *King* were known as constellations in the planispheres of Babylonia and Phoenicia. As I have shown elsewhere, they originally represented certain archaic and pre-constellational ideas. Phaestus was one of the most ancient cities of Crete (*cf.* Il., ii. 648), and one of the three said to have been founded by Minos. Sacred symbols such as these must have been familiar long ere they were reproduced on coins. Hence, we see here on a coin an archaic legend which had already been transferred to the skies, *i.e.*, we have constellation-figures as coin-types. The *Lion*, *Crab* and *Water-snake* of the modern globe preserve the story. *King Herakles* could not be placed next them, even in the Bab. Sphere, as he had already been located elsewhere. These obvious instances justify us in presuming a probable, or almost certain, connection between constellation-figure and coin-type where, at first sight, the evidence may not be quite so clear. Herakles is perhaps the most familiar coin-type throughout Hellas.

No. 3. *Herakles with Bow, Arrow and Birds.* 'Herakles naked, kneeling r. and discharging arrow; before him two birds.' Lamia (Thessaly), B.C. 300—190. This scene is still better depicted on the familiar gem which shows Herakles naked, kneeling on r. knee, Lion's skin over his l. arm, discharging arrow at three birds fronting him in a row. Here we have actually a combination of five constellations, very much as they appear on our globe to-day, *i.e.*, *Herakles*, the *Man kneeling*, discharging his *Arrow* (*Sagitta*) at the three birds, the *Vulture* (*Lyra*), the *Swan* (*Cygnus*), and the *Eagle* (*Aquila*). The ancient little constellation the *Arrow* affords an excellent illustration of the mistaken views which formerly prevailed about these heavenly forms. The great K. O. Müller tells us that there is 'nothing mythological' about it, and that it was named from its 'figure.' Had he been asked, Why, then, was it not called the *Lance* or the *Sceptre*? he could have given no answer except that men chose to call it the *Arrow*, which would be merely to repeat the fact that the ancient Greeks knew it as the *Arrow*, just as we do. As soon as we know the facts, we see why it was called the *Arrow*, and not the *Lance* or *Sceptre*, and observe that it was altogether mythological. This contest of Herakles (Vide No. 4) had its prototype in the fight between the Bab. Merôdach and the three demon birds,[6] *i.e.*, the contest between the Sun-god and the Clouds of storm and darkness. The *Eagle*, the *Kite* (=*Ornis*=*Cygnus*) and the *Lammergeier* appear on the Bab. Celestial Sphere in front of the kneeling *King*. The simple nature-myth had already in the Euphrates Valley been transferred to the starry skies.

No. 4. *Herakles and Bird.* Ob. 'Head of young Herakles in lion's skin. Rev. Head and neck of crested water-bird.' Stymphâlus (Arcadia). B.C. 431—370. Near this very ancient town (*cf.* Il., ii. 608), the name of which is derived from the Ph. *Stembal*, contracted from Mastanabal ('prob. *Clypeus Baalis*,' *i.e.*, the 'Bœotian Buckler' of Herakles), was located the scene of the contest between Herakles and the demon birds (Paus. VIII. xxii. 4). In the mythic pedigree, Stymphâlus is said to have been the great-grandson of Arcas ('the Bright'= the *Bearward*), son of Callisto ('the Most-beautiful')= the *Great-bear*.

No. 5. *Bear.* 'Bear l. walking.' Mantineia (Arcadia). Before B.C. 471. Another coin shows the 'type l.; countermark, star.' The nymph Callisto 'made into the stars

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[2] *Primitive Constellations*, i. 161-241.

[3] Vide *Ibid.* passim.

[4] As the writers I quote are not uniform in their systems of spelling proper names, I do not pretend to uniformity in the matter in this Paper. Despite vehement prejudices, it is much better in scientific works to write proper names in their original forms, *e.g.*, not to clothe a Greek name in a Latin dress, or a Babylonian name in a Hebrew or Greek dress. I use the following abbreviations:—Bab. = Babylonian, Ph. = Phœnician, Gk. = Greek.

[5] Vide Svoronos, *Types mon. des anciens*, pl. xv.

[6] Vide Lajard, *Culte de Mithra*, Pl. lxi. 7.

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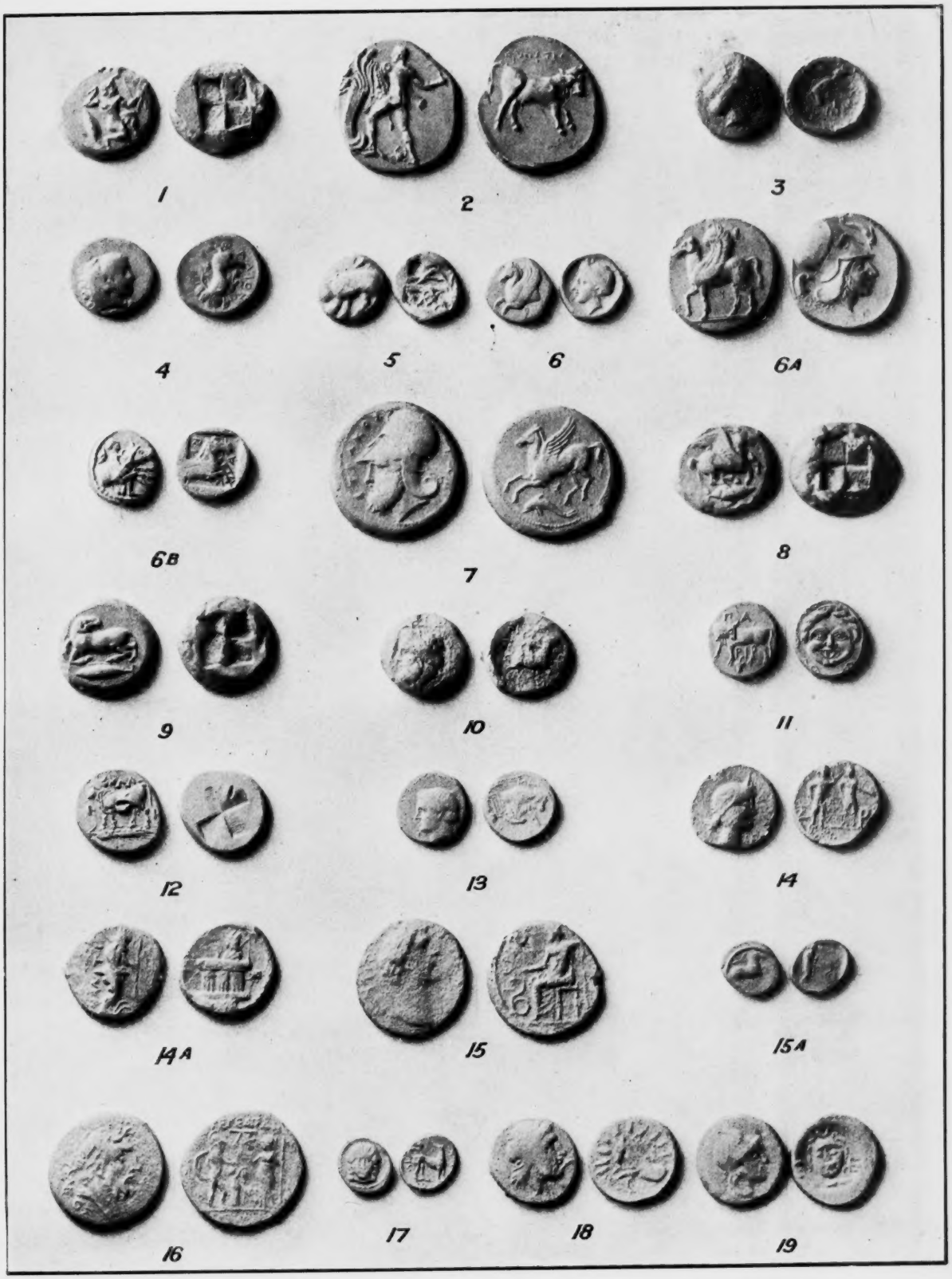

CONSTELLATION FIGURES ON GREEK COINS.

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called the *Great bear*' (Paus. VIII., iii. 3; Vide No. 4). The mythic legend is, of course, vastly older than the coinage.

No. 6A. *Pegasus.* 'Pegasos bridled, with curled wing, walking l.' Corinth. B.C. 400—338. The type appears on the earliest Corinthian coins, B.C. 650. 'The constellation of the *Horse*' occurs in the Euphratean star-lists and in Euphratean art.[7] The Winged-horse was 'familiar to the imaginations of Mesopotamians.'[8] The creature also occurs on a well-known Hittite seal, figured by Wright,[9] Lajard, and others; and appears on coins of Lycia, and on those of the various Corinthian colonies. Sometimes, as in the heavens, a Demi-horse winged is shown, *e.g.*, on coins of the Ph. settlement Lampsacus ('the Passage,' *i.e.*, across the Hellespont). Corinth was the abode of Hipponoös ('the Wise-horseman') commonly called Bellerophon (=Ph. Baal Raphon. Bérard). Pegasus is the Horse 'bridled' (Sem. *Pegah* 'Bridle').

No. 7. *Pegasus and Fish.* 'Pegasus flying; beneath, Dolphin,' an adjacent constellation. Syracuse. B.C. 345. Earlier type *Demi-horse and Fish*, a Ph. coin of Panormus. A combination of *Pegasus* and the *Foremost Fish* in *Pisces.*

No. 9. *Ram and Fish.* 'Ram kneeling l., head turned back; beneath Tunny.' Cyzicus. Cir. B.C. 500—450. It was supposed that the zodiacal *Ram*, the 'pecudem Athamantidos,'[10] the Ram of Athamas (=Tammuz, the Semitic Sun-god), had carried Helle across the Hellespont, near the city. *Aries* has always been represented with reverted head. Thus, Manilius, i. 263-4:—

> 'Aurato princeps *Aries* in vellere fulgens
> *Respicit*, admirans aversum surgere *Taurum.*'

The Northern of the two zodiacal *Fish* 'the Chaldæans call Chelidonias,'[11] the Tunny. There was an important tunny-fishery at Cyzicus, which would influence the choice of symbols.

No. 10. *Ram.* 'Helle seated sideways on ram flying r.' Alus (Thessaly). B.C. 400. Alos, otherwise Aleus (*i.e.*, 'Ram-town,' Heb. and Ph. *Ayil*, Bab.-Assyrian *Ailuv*, 'Ram'), was said to have been built by 'the hero Athamas.'[12] The Ob. bears the head of Zeus Laphystius ('the Gluttonous,' *i.e.*, the Ph. Baal Kronos), to whom human sacrifices were offered. In the time of Pausanias (IX. xxxiv. 1) the spot was still shown in Bœotia where it was said Athamas was about to sacrifice Phrixos and Helle to Laphystius, when they escaped upon the Zeus-sent ram. *Kusariqqu* ('the *Ram*') was the first of the Bab. Signs of the Zodiac. This flying Ram is plainly not a specimen of the ordinary sheep, which men were supposed to put on coins because they saw them around, or bartered them.

No. 11. *Bull and Grapes.* 'Bull standing; beneath, bunch of grapes.' Parium (Mysia). B.C. 400—300. A colony of Miletus (Vide No. 1), Paros, and Thasos, Ph. centres. The *Clusterers* (*Pleiades*) are frequently represented in coin symbolism by a cluster of grapes (*βότρυς*). 'They are called a grape-cluster.'[13] A coin of Mallos in Cilicia shows doves whose bodies are formed of bunches of grapes, 'the dove-emblem and the grape emblem of the Pleiad being here united or intermixed.'[14] Prof. Thompson well points out the connection between *Oinas*, 'a kind of wild dove' (Hesychios), *Oinos*, wine, and the Semitic *younah*, *ionah*, 'dove.' The whole form a commingling of etymological connection and similarity of sound such as symbolism delights in. The *Grape-cluster* also appears on coins of Arvad and of Juba II., in the latter instance with a 5-rayed star, perhaps the Pleiad. So, again, on the coinage of Tauromenium (Sicily) we find 'Bull's head. Rev.: Grape-cluster.'

No. 12. *Bull and Ear-of-corn.* 'Bull standing on ear of corn.' Calchedon. Cir. B.C. 400—350. The Ear-of-corn has been from remotest times a symbol of the goddess Ishtar (Astarte-Aphrodite), the original zodiacal *Virgo*, with her star *Spica*. Both the goddess and the Bull have a primary lunar connection, and this exact combination of Bull and Ear-of-corn appears on Euphratean cylinders of remote antiquity. The scene is not a bull in a cornfield, but a bull standing on a single ear of corn nearly as big as himself.

No. 13. *Demi-bull.* 'Forepart of rushing bull.' Magnesia ad Mæandrum. Cir. B.C. 350—190. Another coin shows 'Humped bull butting.' We have already met with *Taurus* and *Pleiades* (No. 11), and *Taurus* and *Spica* (No. 12). Here is the exact zodiacal *Taurus*, demi, gibbous, and with bent leg. The farmer would not notice demi-bulls and demi-horses in his fields. The moon-bull is, of course, at times demi; as is the solar Horse, when he rises and sets, especially from or into the sea.

No. 14. *Twins.* 'Altar or shrine surmounted by the busts of the Dioscuri, wearing *pilei*, their heads and shoulders appearing over the top.' Mantineia. B.C. 431—370. We also find 'Two male figures (the Cabiri) standing facing, their right hands resting on their hips.' Syros. Third to first century B.C. Another type is '*Pilei* surmounted by stars,' *i.e.*, the 'fratres Helenae, lucida sidera,'[16] Castor and Pollux. The Euphratean name of the constellation was 'the *Great Twins.*' I believe the *Twins* are sometimes represented by Harmodius and Aristogeiton, as on a coin of Cyzicus, a city which shows eleven Signs of the Zodiac on its coinage (Vide No. 1).

No. 15. *Snake-holder.* 'The Asklepias of Thrasymedes.' Epidaurus. A reproduction of the earlier coin-type of B.C. 325-240. The famous statue of the god, with his hand on his serpent's head, is described by Pausanias (II. xxvii. 2). On the Ph. coinage of Kossura a 'Cabirus' (Ph. *Kabîrim*, 'the Great-ones') is depicted 'serpentem tenens.' This personage is the 'native Ph. god'[17] Eshmûn ('the Eighth'—of the Kabîrîm), whose name, in a trilingual Inscription of Sardinia,[18] is rendered 'Asklêpios' and 'Aescolapeius.' He was a great patron divinity of Epidaurus, and was there regarded as the constellational Snake-holder.[19]

No. 16. *Cepheus.* 'Pallas and Cepheus, both armed, standing face to face, the goddess hands to the hero the head of Medusa; between them, Sterope r., who holds up a vase to receive it.' Tegea. After B.C. 146. Pallas, Medusa and Sterope appear in the same connection on earlier coins. Local legend:—Pallas promised Cepheus, son of Aleus (Vide No. 10), that Tegea should never be captured, and gave him one of the locks of Medusa as a protection for the city.[20] The local tradition, like so many recorded by Pausanias, is an attempt to explain facts

[7] Vide R. B. Jr., *The Heavenly Display*, Fig. lxv.

[8] Perrot, *Hist. of Art in Chal.* ii. 171. Vide Fig. 89, 'Winged Horse.'

[9] *Empire of the Hittites*, Pl. xvi.

[10] Ovid, *Fasti*, iv. 903.

[11] *Schol.* in Arat. *Phainom*, 242.

[12] Strabo, IX. v. 8; vide No. 9.

[13] *Schol.* in *Il.* xviii. 486.

[14] D'Arcy Thompson, *Bird and Beast in Anct. Symbolism*, p. 183.

[15] Vide R. B. Jr., *The Celestial Equator of Aratos*, Fig. 7, p. 11.

[16] Horace, *Car.* I. iii. 2.

[17] Damaskios, *Isidorou Bios*, cexlii.

[18] *Corp. Ins. Sem.* cxliii.

[19] Vide *Katas.* vi.; Hyginus, *Poet Astron.* ii. 14; etc.

[20] Paus. VIII. xlvii. 4.

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the real meaning of which had long been forgotten. This Cepheus, who was ultimately supplied with a pedigree from Lycaon (*i.e.*, the votary of Zeus Lycaios),[21] Callisto (the *Great-bear*), Arcas (1. 'Le dieu-soleil,' and 2. The *Bearward*) and others, is really identical with the Ph. and constellational Cepheus.[22] We have here a remarkable picture of a portion of the heavens. *Cepheus*, who was also Baal Tsephôn ('Lord-of-the-North'), from near the Pole, drops, as it were, *Medusa's Head* (*i.e.*, the star *Algol*, 'the Ghoul,' evidently so styled from its extraordinary variations in brilliancy) into the vase held up by *Sterope* ('the Bright' or 'Lightner'), one of the *Pleiades*, immediately beneath.

No. 17. *Virgin and Dog.* Ob. 'Head of Aphrodite of Eryx.' Rev. 'Hound looking back.' Period of transition. Town finally destroyed in the first Punic War. A very ancient seat of the Ph. cult of 'Aschthârth Erek-hayîm ('Astarte longae vitæ auctor'), called Aphrodite Erykine,[23] and, in Attica, Erigone, who, according to the Athenian legend, was changed into *Virgo*, and her faithful little dog, 'canis ululans Mera,'[24] Maira ('the Sparkler'), into *Procyon*. Dogs were sacrificed to the Ph. goddess 'Aschthârth Melekhet[25] Aschamâîm ('Astarte, Queen of heaven') = Aphrodite Ourania.

No. 18. *Sirius.* 'Forepart of dog l. surrounded by rays; Sirius.' Ceos. Second Century B.C. Very early coins of Carthæa, the ancient Ph. capital of the island, bear (1) an *Amphora*, which from the Bab. Cylinders downwards, is a frequent symbol of *Aquarius*; or (2) a *Dolphin*, the fish sacred to the Ph Poseidon; or (3) a *Bunch of Grapes* (Vide No. 11). Local legend:—Aristæus prays to Zeus and *Sirius* against the plague. Other coins of Ceos bear a Star (*Sirius*) only on the Rev. The cult of astral divinities is not naturally Helenic.

No. 19. *Perseus.* Ob. 'Helmeted head of Perseus r.' Rev. 'Gorgon's head; beneath, *harpa* r.' Seriphos. Cir. B.C. 300. Perseus was especially honoured here.[26] The scimitar or sickle with which the Bab. Merôdach is armed in his fight against the Dragon, reappears as the sickle used by the Ph. Kronos against Ouranos. This weapon, called in Canaanite *khereb*, a word which the Egyptians borrowed in the form *kurp*, is the *harpê* which the Ph. Perseus uses against the *Sea-monster* (*Cetus*), which latter constellation-figure appears on the coins of Itanos (Crete) and Agrigentum. The whole story of Cepheus, Cassiepeià, Andromeda and Perseus is Phœnician.[27]

Such are a few instances of Greek constellation-figures as coin-types. How they got there is no legitimate cause for wonder. Their absence from the coins would have been truly remarkable. For, the great historical fact underlying the whole matter is simply that at an early period, long before coined money, Semites skilled in letters, navigation, astronomy, etc., invaded Hellas; and that the Greeks, the quickest of mankind, promptly absorbed this knowledge, reproduced and bettered it. The Greeks themselves were not naturally stellar votaries. Their great Aryan divinities, Zeus, Hera, Aïdôneus (=Pluto), Demeter, Hestia, Hephaistos, Apollo, Athena, Artemis, Hermes, Pan, etc., do not appear as sky-figures. It is the Phœnician personages, Poseidon (=the *Charioteer*),[28] Herakles (=the *Kneeler*), Eshmûn (=the *Snake-holder*), Aphrodite (=the *Virgin*), Cepheus and his family, Arcas (=the *Bearward*), etc., with sacred animals of Western Asia, *e.g.*, the Bear, Serpent, Horse, Lion, Dog, Eagle, Dolphin, etc., that we find sphered on high. And, lastly, history, archæology, and astronomy unite in showing that a region of which Babylon was about the southern point, was the primitive home of most of the constellation-figures which we have received through the medium of Greece.

NOTE.—The following coins are also shown on the Plate:—

No. 6. *Pegasus.* Corinth. Cir. B.C. 431—338. Rev. Head of Astarte-Aphrodite.

No. 6B. Rev. *Pegasus.* 'Forepart of bridled horse galloping r.' Larissa (Thessaly). B.C. 480—450.

No. 8. Ob. *Pegasus.* 'With pointed wing flying r.: beneath tunny.' Cyzicus. B.C. 450—400.

No. 14A. *Twins.* Rev. 'Altar surmounted by the busts of the Dioscuri l., wearing *pilei*, their heads and shoulders appearing over the top.' Mantineia. B.C. 431—370.

No. 15A. *Snake-holder.* Rev. 'Asklepius feeding serpent from *patera*.' Larissa. B.C. 450—400. The Horse on the Ob. may be *Pegasus* (Vide No. 6B).

[21] The Ph. Light-god (Vide Bérard, *Des Cultes Arcadiens*, p. 49 *et seq.*)

[22] Ph *Kêph*, the sacred 'Stone.' Cf. *Cephas.*

[23] Paus. VIII. xxiv. 6.

[24] Hyginus, *Fab.* CXXX.

[25] Vide Movers, *Die Phönizier*, i. 404.

[26] Paus. II. xviii. 1.

[27] Vide Gruppe, *Der phoinikische urtext der Kassiepeia-legende*, 1888.

[28] Vide R. B. Jr., *Primitive Constellations*, i. 41-2.

THE CANALS OF MARS.

By Miss M. A. ORR.

THE physical condition of Mars is a problem over which discussion still rages with unabated vigour. While Mr. Lowell sees in the Martian "canals" a vast system of artificial irrigation, and M. du Ligondès geological fissures, through which rise to the frozen surface vivifying vapours from a still heated interior, M. Antoniadi ascribes their doubling to a defect in focussing, and others disbelieve in even their single existence. But the enigmatical lines have appeared to so many, and in the main with such consistent similarity, that the ranks of these unbelievers grow thin. Between rejecting the canals altogether, however, and accepting them as actual physical entities, there are other possible alternatives. Mr. Walter Maunder, in an article in KNOWLEDGE for November, 1894, and more recently Signor Cerulli, in recounting his observations of Mars in the opposition of 1896-7, at his private observatory of Collurania (Teramo), showed how the mathematical lines and spots we find in the faint markings of Mars might be merely the easiest form in which, with our present optical means, we could be cognizant of its real features. This latter treatise elicited replies from Schiaparelli and Flammarion, but their arguments in favour of the physical existence of the markings as such, and of actual changes taking place in them, are not altogether conclusive. Signor Cerulli's observations during the last opposition have confirmed him in the belief that the markings are optical, and his new report* is substantially a full exposition of his theory. These observations extended from August, 1898, to March, 1899, and were made with a 15½ in. Cooke equatorial, with powers of 400 and 500, always without stops or coloured screens, the object being not to get sharp definition of any special feature, but as complete a picture as might be of all the phenomena. The author shows what is the explanation, on his theory, of the features seen and their apparent variations, and brings forward ingenious and novel arguments to prove his case.

It must be remembered that in a bird's-eye view of a

* NUOVE osservazioni di Marte: Saggio di una interpretazione ottica delle sensazioni areoscopiche. By V. Cerulli. Collurania, 1900.

world some 40 millions of miles away all we can take note of are contrasts in tone and colour, while the real contour of objects is masked or invisible. Small or faintly-shaded objects, invisible singly, will produce an effect, if close together, of one large mass, and from our inability to see the irregularity of their grouping, will appear as round spots or long streaks. But conditions of seeing vary enormously on Mars, according to its distance and position, and the changing illumination of its disc; not to speak of variations in ourselves, our atmosphere and our instruments; the contrasts, therefore, will vary, more detail will sometimes be seen in the patches and streaks, fainter markings at their edges will appear and disappear, altering their outline and extent. The hazy aspect of Schiaparelli's canals may thus be a nearer approximation to reality than the sharply defined, and the doubling may be due to disappearance of faint shadings between more easily grasped boundaries. That the canals were discovered after the opposition of 1877, being only suspected during the most favourable period, that they are sharpest with coloured screens and comparatively small apertures, while in the great Lick and Washington telescopes they have been seen either as few diffused markings, or not at all, suggest that the fine lines are simply a mode under which faint markings may present themselves to imperfect vision. There is undoubtedly truth in the apparent paradox that greater distinctness comes with poorer vision, for in the best moments the eye dimly perceives, even where it cannot grasp, divisions in simple masses, curves and blurring in narrow lines, indeterminate shadows in clear spaces.

Whether the optical theory accounts for *all* the variations, including those of the polar caps, the future must decide. Most interesting is Cerulli's appeal to the past history of areography, referring to Flammarion's valuable collection of drawings, all carefully copied from originals, in his "Planète Mars." Here we may see how in the first rude telescopes impressions of Martian markings were summed up in one large round spot, or one wide band, which latter was by Cassini and some others seen double. By degrees the easiest features of the southern hemisphere were distinguished, but appeared so variable that an atmospheric origin was ascribed to them. It is particularly instructive to compare Knott's drawing of November 3, 1862, with Lord Rosse's of three days later. Knott's telescope was of $7\frac{1}{3}$ in. aperture, and the features which in the 6 ft. Rosse reflector appeared as large dark patches on a fainter background, he portrays as narrow lines on white—canals on a large scale. Again, in two excellent drawings by Kaiser, a broad band where we now recognise Praxodes, seen at the opposition of 1862, becomes, six weeks later, when seeing was more difficult, two narrow bands with faint shadings between. Other examples of gemination in lines and in spots, contractions and enlargements, etc., may be traced, and through all the series there is a remarkable, but in no wise astonishing, variety of representation. One has but to consider the fugitive faintness of the objects, the imperfections of the instruments, and the personality of the observers, which affects not only their vision but their mode of portrayal. On this last point, which comes out very clearly on an examination of the illustrations in "La Planète Mars," Signor Cerulli has not perhaps laid enough stress, nor on the influence of unconscious imitation.

Mr. Green, the artist astronomer, used to insist on the importance of the trained hand as well as the trained eye in order to obtain true pictures of planetary detail.

Is the history of discovery with regard to the large markings in Mars' southern hemisphere repeating itself now with the more delicate shadings in the northern? and with better optical means would they also lose their misleading appearance of mathematical regularity, and their instability?

The artificial origin of the Martian "canals" can hardly be maintained now that they have been seen to traverse the polar caps, and to appear in Venus, Mercury, and two of the Jovian satellites. On the optical hypothesis, on the other hand, this is precisely what we might expect. It is perhaps going too far to suggest that the bands of Jupiter and their varying appearances are strictly analogous to canals, since their atmospheric origin is rendered probable by other considerations, notably by the planet's low density; yet there is certainly a startling resemblance between some early drawings of Mars and recent diagrams of Jupiter. Schröter's Mars, for instance, on page 77, Fig. 48, of "La Planète Mars" (1892 edition), tempts one to quote Dante:—

† "Such would Jove become, if he and Mars
Were birds, and changed their plumage."

We are indebted to M. Flammarion for another line of evidence. He had the happy idea of collecting naked eye views of the moon by different observers, and in response to his appeal an interesting series appeared in the "Bulletin de la Société Astronomique de France," from January to June of last year. The disc of the moon to the unaided eye is about the same size as that of Mars in an average telescope, but the conditions are not quite the same, as naked eye vision does not admit of straining and mis-focussing to the same extent as telescopic. Nevertheless, the study of these drawings is, as M. Flammarion remarks, a lesson on the value to be attached to observations at the limit of visibility, and no one would have believed that the same thing could have been represented in so many different ways. The reader may judge for himself by personal examination whether these drawings support Cerulli's theory of the canals. He will not fail to observe a tendency to draw the Seas of Serenity, Tranquillity, Plenty, and Nectar, as two lines more or less parallel, while the Ocean of Tempests is sometimes a narrow curved line, its eastern border only being seen, in contrast with the brilliant limb. Tycho in one instance appears as a very large bright *square*.

Whether the optical theory be correct or no, probably no one will deny the wisdom of Signor Cerulli's advice to regard all Martian maps as temporary guides, sure to be modified by further investigation. We may add, however, that to refrain altogether from speculative hypotheses would be as unscientific as uninteresting; the sensational theories about Mars have been a stimulus to much excellent work; but the scientist remembers that they are only theories, and is prepared to see them dispelled by fuller light.

Letters.

[The Editors do not hold themselves responsible for the opinions or statements of correspondents.]

GRADUAL CHANGE IN OUR CLIMATE.

TO THE EDITORS OF KNOWLEDGE.

SIRS,—Is our summer half (in London) getting colder

† "Qual diverebbe Giove, s'egli e Marte
Fossero augelli, e cambiassersi penne."—Par. xxvii. 14, 15.

and drier? I would invite attention to the following facts in this relation:—

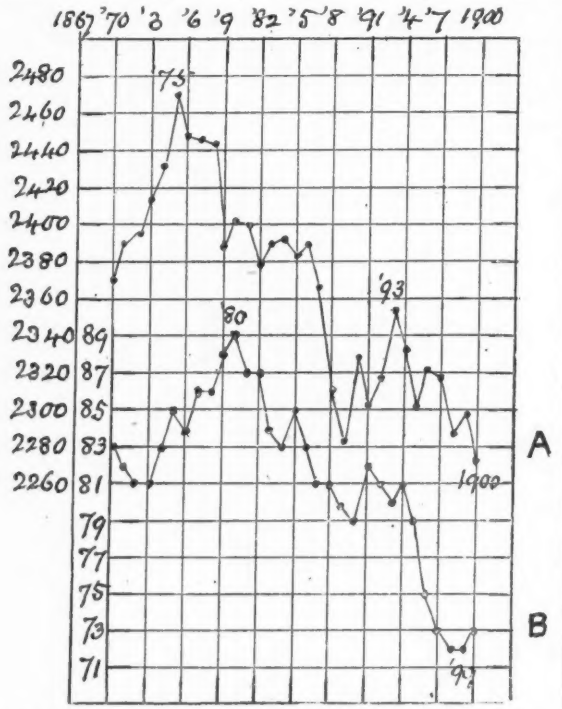
1. The last 30 years (1871-1900) contain a smaller number of days with maximum temperature, 70° or more, than any other 30 consecutive years since 1841. (Of such groups there are obviously 31.)

Curve A shows the general decline in those values. The first year-point represents the number of those hot days in the 30 years ending 1870, the next in the 30 years ending 1871, and so on. The difference between the highest and the lowest point is 2470 – 2273 = 197.

Next, let us consider the number of wet months in the summer half (April to September) in 30 years ending 1870, '71, &c. We have the curve B, showing also a general decline. We may say this about it:

2. In each of the 30-year groups ending 1898 and '99, the number of those wet months was less than in any other group (than these two) of 30 consecutive years since 1841. (The value for 1900 shows a slight rise.) The difference between the highest and the lowest value is 89 – 72 = 17.

I do not represent that this gradual decline is likely to continue. More probably we shall ere long find compen-



A. Days with maximum temperature 70° or more in 30 years ending 1870, '71, etc.
B. Wet months in summer half in 30 years ending 1870, '71, etc.

sation, and a rise in the curves. It seems desirable to get light on the limits and cause of those variations.

ALEX. B. MACDOWALL.

RAINBOW PHENOMENA.

TO THE EDITORS OF KNOWLEDGE.

SIRS,—The double rainbow observed by MR. S. R. S. Brown at Eastbourne, and recorded in KNOWLEDGE for December, 1900, must have been a very good example of what are called "supernumerary" bows, and which are said to be due to interference (*see* Scott's "Elementary Meteorology," p. 200, 1st Edition), but I would like to see the mathematical proof of this.

I have often noticed these supernumeraries, but never more than three inside the primary bow. It would be interesting to know if any one has ever observed the same thing in connection with the secondary bow. Sometimes the bow has been nearly the complete semi-circle, and at others and more commonly only a very small segment of the bow was projected above the horizon. One especially which I observed in Essex a good many years ago was very brilliant, and the third or inmost supernumerary only just cleared the horizon. I fancy they are always present and to be seen provided the sun's rays are bright enough and the background of cloud is dark enough.

On the 26th September last I saw a rainbow which besides exhibiting the supernumerary bows had another variation, which I described as follows in my weather record:—"The bow seen at 5.30 p.m. showed inside the ordinary primary, and close to it two supernumerary or interference bows; at about half the height of the bow a short piece of the supernumerary bows was broken from the circular band of the bows, and stood at an angle of 15° to 20° from the circle of the bows. The whole bow was standing against the streaky cloud rays which accompanied a shower that had just passed over, and these streaks seemed to be in some degree parallel to the broken piece of the supernumeraries."

As to the cause of this there must have been a reflection of the sun's rays in some way.

I should add for the further information of those interested that the ground to the west rises gradually, and that the clouds on which the bow was projected were over Lake Temiscamingue, which gave me a good view of the phenomenon. PAUL A. COBBOLD.

Haileybury, Ont., Canada,
December 16th, 1900.

"IS HUMAN LIFE POSSIBLE ON OTHER PLANETS?"

TO THE EDITORS OF KNOWLEDGE.

SIRS,—Your correspondent A. D. Taylor enquires in the January number of KNOWLEDGE as to whether those who have made a study of the planets can throw any light on the above subject. He especially calls our attention to the planet Mars, a planet which he has hitherto considered suitable for the maintenance of human life. In passing rapidly over these controverted subjects we may say that the greater part of the surface of this planet is desert, that the water supply is very scanty,—the greenish looking patches on the planet, which have hitherto been considered seas, are, according to Mr. Percival Lowell, nothing but large tracts of vegetation growing in the bottoms of the old s as. The inhabitants, if such there were, would be dependent for their water supply from the annual melting of the polar snow or hoar-frost. The atmosphere is thin, and consequently free from clouds; it is doubtful whether there are any rainfalls on the planet, the moisture being deposited in the form of dew or hoar-frost. The question of the composition of the Martian atmosphere is of the greatest importance. Your readers are aware that the chemical composition of any atmosphere is dependent on the critical temperature and the critical velocity of its gases. In other words, if the gravitational pull of a planet is not greater than the critical velocity of its gases, the molecules of gas will leave the planet never to return. In the case of Jupiter, we find the atmosphere is exceedingly dense, while such bodies as Mercury

and our own moon are practically devoid of atmosphere. It has been assumed that the atmosphere and water (converted into water-vapour) of the moon have been, by molecular motion, drawn down to the surface of the earth. If this be the case, therefore, we do not know what gases and vapours may not have been liberated from the surface of Mars. On this question, I think, the whole subject hangs. There is no reason for doubting that, given the necessary elements for the formation of living matter, the organic kingdoms may not have followed the same course of evolution as our own. The organisms are perhaps larger, owing to the lesser pull of gravity on that planet. In conclusion, I should advise Mr. Taylor to read Percival Lowell's admirable work on "Mars," if he desires to enter into the subject more fully.

THOMAS R. WARING.

Liverpool.

TO THE EDITORS OF KNOWLEDGE.

SIRS,—In reply to Mr. Taylor's query I should say that most scientific men would undoubtedly give a very decided "No" to his question, and for the following two good reasons:—

First—There is not one chance in a million that any two planets among the unnumbered myriads that probably exist in space utterly unknown to us have, in the course of evolution, become so similar in their physical conditions as to be sufficiently fitted for the inhabitants of each other to be able to continue to maintain their existence if they interchanged worlds.

Secondly—Granting that the physical conditions of two planets may be sufficiently similar to enable most of the forms of life on the one to exist on the other, yet the chances against identical or even similar forms being found on both are immense. The almost infinite complexity of circumstances which, in the long course of evolution, has moulded living organisms on our earth to what they are will have acted equally on every other planet, and effectually precluded any two forms being similar except in the remotest sense of the term.

No doubt such planets as Mars are teeming with life, but each one with life peculiar to itself, fitted by Nature to the surrounding conditions, and no others. Looking to man, we see, as Sir Robert S. Ball remarks, that "he is a creature adapted for life under circumstances which are very narrowly limited. A few degrees of temperature, more or less, a slight variation in the composition of air, the precise suitability of food, make all the difference between health and sickness, between life and death."

Intelligence may—nay, probably has—a home on distant spheres, but in forms stranger than have ever been imagined by us.

ARTHUR ED. MITCHELL.

Oxenhope, nr. Keighley,
January 8th, 1901.

Notices of Books.

"ESSAYS IN ILLUSTRATION OF THE ACTION OF ASTRAL GRAVITATION IN NATURAL PHENOMENA." By William Leighton Jordan, F.R.G.S., etc. (Longmans.) 9s.—Mr. Jordan is by no means satisfied with the current opinions of men of science on the fundamental principles upon which the systematised body of knowledge called science is based. Though he has written other books, this is the first which has come under our notice, and from a somewhat careful reading the conclusion arrived at is that there is more valuable material to be obtained elsewhere. No good end would be served by dealing with each of the six essays in detail. It must suffice to take one as an example. This is called "Sir Isaac Newton and Modern Chemistry." One or two short quotations will serve the useful purpose of enabling the reader to form for himself an estimate of the value of Mr. Jordan's contribution to science. "Among the important advances in scientific knowledge . . . . there has been a tendency in the direction of showing that material substance exists only within a limited range of temperature: that is to say, that a sufficient rise or fall of temperature will transmute any form of matter into immaterial force." (p. 159) "Too limited a view seems to be taken of the extent and powers of nature in supposing material atoms to be unchangeable, for that idea in fact places these atoms above the powers of nature, and might indeed almost be said to make them nature's gods." (p. 161.) On page 162, "atoms of pure water" are spoken of. On page 185 occurs this statement:—"Careful experiments in closed vessels have shown that this (increase in mass on oxidation) is due to a transmutation of air into metallic substance during the process of calcination; and in this case a return to normal temperature does not retransform the metal to air." For the present it would seem advisable to content ourselves with mere orthodox physics and chemistry.

"LORD LILFORD (THOMAS LITTLETON, FOURTH BARON)." A Memoir by his Sister, with an introduction by the Bishop of London. (Smith, Elder.) Illustrated. 10s. 6d.—Pending a more elaborate biography, Mrs. Drewitt has put together a brief memoir of her brother, the late Lord Lilford. It was as an ornithologist that Lord Lilford was chiefly famed. He was of too retiring a nature to publish much, but his works on the "Birds of Northampton," and his "Coloured Figures of the Birds of the British Islands" are well known, while a number of valuable papers from his pen appear in the *Ibis* and other publications. Although he had the grievous misfortune in the prime of his life to become a martyr to rheumatic gout, which confined him to a bath chair for practically the remainder of his days, he was an ardent sportsman, and a still more ardent lover and observer of nature. As a man he was generous and liberal in the extreme, and so unostentatious was his beneficence that the extent of it can never be gauged. His affliction caused him intense suffering, and, moreover, made him completely helpless, which to a man imbued with instincts of sport and travel must have been the deepest trial, yet he counted his life a happy one, and never complained of his lot. The most interesting part of this memoir will be found in the letters written at various times to his friends. They show the character of the man, as well as his intimate knowledge and great love of animal life, and especially of birds. The illustrations are chiefly of birds from the collection at Lilford Hall. There Lord Lilford had gradually brought together an extraordinary collection of live birds, which were kept in a state of freedom only second to nature. Many of these birds were of great rarity. Many he had obtained himself during trips to Spain and various parts of the Mediterranean. Some notes written for the Natural History Society at Northampton by Lord Lilford on his aviaries appear in the memoir, and will give an idea of the extent and richness of the collection.

"PROBLEMS OF EVOLUTION." By F. W. Headley. (Duckworth.) 8s. net.—Though Lamarckism is a century old, and Darwin's "Origin of Species" was published in 1859, naturalists are still divided in their opinions as to the causes which have determined the evolution of plants and animals. Lamarck maintained that external conditions modify the individual and that the next generation inherits the modification. Darwin showed how the struggle for existence could account for the survival and propagation of organisms which varied from the normal in characteristics best suited for the environment in which they happened to be. If the Lamarckian principle is true, then the part played by natural selection in producing new species is comparatively small, hence the two hypotheses oppose one another and provide much material for discussion. There are naturalists who accept the fundamental idea of Lamarck, but a much larger school follows Darwin and Wallace. A new epoch was commenced by Prof. Weismann, whose brilliant studies command the attention of biologists, even though objection may be raised to the doctrines which have grown out of them. "Weismann," to use Mr. Headley's words, "saw two very remarkable phenomena for which a theoretical basis must be found. First, heredity, the recognised fact that sons closely resemble their parents; secondly, the fact, as he himself considered it to be, that acquired characteristics are not

inherited: that if the speed of a horse is increased by training, the increase of muscular power so obtained is not transmitted." Weismann has provided biological explanations of these phenomena, his chief generalisations being that the reproductive elements—the germ-plasm—of the higher organisms are immortal, while the rest of the body—the somatoplasm—dies. Such are baldly some of the chief speculations with which Mr. Headley is concerned. One of the main objects of the book is to show that the Lamarckian view has no basis in fact, and that it offers no explanation of the phenomena of animated nature. At the same time this is only one of the objects, for the volume consists of two parts, the second being taken up with the problems of human evolution. Human evolution is treated of under the headings of physical, moral, and intellectual evolution, and the question of physical degeneration is dealt with very fully. Mr. Headley writes in a stimulating and interesting manner, and avoids any partisanship very successfully. To anyone who wishes to read an up-to-date account of evolutionary theories, Mr. Headley's book can be recommended in full confidence.

"Studies: Scientific and Social." By Dr. Alfred Russel Wallace. Two volumes. Illustrated. (Macmillan.) 18s.—In these two volumes we have an epitome of Dr. Wallace's views on many subjects of science and philosophy, covering a period of about thirty-five years. The essays have appeared in reviews and other publications, and have not only been enlarged and simplified in places, but have also been given additional interest by numerous striking illustrations. There are, in the first volume, essays on questions of physical geology, descriptive zoology, plant distribution, animal distribution, the theory of evolution, anthropology, and instinct; while the second volume contains contributions on educational, political, ethical, and sociological subjects. The ground covered is thus so extensive that it cannot be adequately surveyed in a short review; therefore we must content ourselves with mentioning a few of its prominent features. Dr. Wallace holds that the oceanic areas beyond the depth of 2000 fathoms, constituting about seventy per cent. of the whole ocean floor, have been ocean throughout all known geological time. There has been a large amount of controversy over this question of the permanency of the ocean bed, but in England a compromise seems to have been effected between the two schools of geologists. Dr. Wallace remains in possession of his 2000 fathom boundary—at least so far as Mesozoic and subsequent ages are concerned—but abandons his earlier limit of 1000 fathoms. He accepts the Rev. O. Fisher's conclusion that the average thickness of the earth's crust on lands near the sea-level is only about eighteen miles, which is all that separates us from a layer of molten lava. It can scarcely be said, however, that the data available are sufficiently exact to justify any very definite pronouncement upon this matter. The valley-lakes of highly-glaciated districts are believed by Dr. Wallace to have been formed by ice-action. This view of Ramsay's is maintained by a group of distinguished geologists, but others—Prof. Bonney among them—explain the lakes as the result of earth movements and other causes. Wales, Scotland, Switzerland, Scandinavia, and North America all present an abundance of these lakes, and all of these countries have been subjected to glacial action. On the other hand, as Mr. Oldham pointed out some time ago, there are valleys in regions showing no effects of glaciation, very similiar to those in which lakes occur, but filled with the *débris* of rocks instead of water, and there is no evidence that they have been scooped out by glacier action. The biological essays are most interesting to read, and several of them set forth in the clearest possible manner the theory of the origin of species by means of natural selection. Dr. Wallace shows that objections to the theory are often based upon incorrect interpretations of facts of natural history. He will have nothing to do with discontinuous variation or the inheritance of acquired characters, or any other modification or substitute for the Darwinian hypothesis as the method of organic evolution. His definite conclusion, after examining the cases put forward by naturalists who seek for a modified Darwinianism, is that "no case has yet been made out for the inheritance of individually acquired characters, and that variation and natural selection are fully adequate to account for those various modifications of organisms which have been supposed to be beyond their power." No space is left even to mention the other subjects dealt with in the volumes—the disguises of insects, the distribution of animals, the functions of museums, the origin of speech, the nationalisation of the land, and other matters of human interest. There are fifty-two essays in all, and each of them will prove a source of instruction to the reader. Few men have wider sympathies with Nature than Dr. Wallace, and none have a more extensive influence.

"Publications of the Lick Observatory," Volume IV., 1900.—"Meridian Circle Observations of 310 Standard Stars." By R. H. Tucker.—This is a work of great importance for professional astronomers, being the systematic and repeated observation of the standard stars of the four great ephemerides of the United States, England, France, and Germany, carried out with the thoroughness and skill which are associated with Mr. Tucker's name. A full description of the instrument, of the methods of observation, and of the corrections, is given in the Introduction.

"Who's Who. 1901." (Adam and Charles Black.) 5s.—We suppose it will always pass the wit of man to set up a standard of distinction in the preparation of a work of this kind, but the continuous growth of a miscellaneous crowd of country J.P.'s, obscure M.P.'s, and still more obscure peers, will certainly necessitate some rule on the subject, or it may become a greater distinction to be out of the book than in it. Apart from this obvious danger to the utility of the work, it may be most heartily commended for its lucid and informing character throughout, and if it should happen that one wants to know anything about anyone at any time, then the information is most likely to be contained in "Who's Who." But there is such a distressingly large number of names of whom it may be safely said that few people will ever have any occasion to consult their record, to become interested in their orderly progress from the University to the Bench, or excited concerning their recreations. Still "Who's Who" is a great work, grateful to the journalist, and comforting to those included in its pages.

"The Englishwoman's Year Book and Directory, 1901." Edited by Emily Janes. (Adam and Charles Black.) 2s. 6d. net.—A truly remarkable record of the successful result of sustained effort. So far as we can see, covering the whole field of their activities, the book is an object lesson in the amazing advances of women during the past few years in every branch of human activity.

A copy of Darwin's "The Origin of Species" can now be obtained for the sum of 2s. 6d., Messrs. Murray having, on the approaching expiration of the copyright of that work, issued a cheap edition. The new book has a cover which will not shame any library, and is well printed on thin paper. That the mass of erroneous and harmful ideas which associate themselves in the popular mind with the name of Darwin will be replaced by clear perceptions of his theories is a hope too sanguine perhaps to be fulfilled. But to possess may mean to peruse, and Messrs. Murray have at least removed the excuses of those who have light pockets.

We have received from the Hon. Secretary of the Anthropological Institute a copy of the first number of a new monthly journal entitled "Man," to be devoted to the record of progress made in the various branches of the study of mankind. The scope of the new periodical will include physical anthropology, ethnography, psychology, the study of language, and of the earlier stages of civilization, industry, and art, as well as the history of social institutions and of moral and religious ideas, so that there should be no lack of material wherewith to fill the allotted number of pages. A wise provision in the scheme is the concentration of attention on those sections of its subjects which at present suffer from lack of a journal devoted to their special interests. In addition to occasional text figures, each number will be illustrated with a full-page plate. That there is room for such a journal there can be little doubt, and the January issue promises well for the future. This part contains five original articles, one of which is illustrated with a coloured plate of the Japanese "Wheel of Life." These are followed by nine reviews from the pens of well-known authorities. Each article is headed by a short "subject-title" in large type, and is also marked with a reference number by which it should be quoted. The annual subscription for the general public is ten shillings. The new venture has our hearty good wishes.

BOOKS RECEIVED.

The Complete Works of John Keats. Vol. II. Edited by H. Buxton Forman. (Glasgow: Gowans & Gray.)

Text-Book of Zoology. Part III.—Invertebrates. By Dr. Otto Schmeil. (A. & C. Black.) Illustrated. 3s. 6d.

Modern Chemistry—Theoretical. By William Ramsay, D.SC. (Dent.) 1s. net.

Modern Chemistry—Systematic. By William Ramsay, D.SC. (Dent.) 1s. net.

Practical Enlarging. By John A. Hodges, F.R P.S. (Iliffe, Sons & Sturmey.) Illustrated. 1s. net.

Periodic Classification and the Problem of Chemical Evolution. By George Rudorf, B.SC. (Whittaker.) Illustrated. 4s. 6d.

The Self-Educator in Latin. By W. A. Edward, M.A. (Self-Educator Series.) (Hodder & Stoughton.) 2s. 6d.

Primer of Astronomy. By Sir Robert Ball, LL.D., F.R.S. (Cambridge Science Primers.) (Cambridge: University Press) 1s. 6d. net.

The French Revolution. By Thomas Carlyle. (Ward, Lock.) 2s.

England's Neglect of Science. By Prof. John Perry, M.E., D.SC, F.R.S. (Fisher Unwin.) 2s. 6d. net.

Imitation; or The Mimetic Force in Nature and Human Nature. By Richard Steel. (Simpkin, Marshall.) 3s.

Smithsonian Institution. Annual Report of the Board of Regents. Smithsonian Institution. Report of the U.S. National Museum.

Lunar Theory, Lectures on the. By John Couch Adams, M.A., F.R S. (Cambridge: University Press).

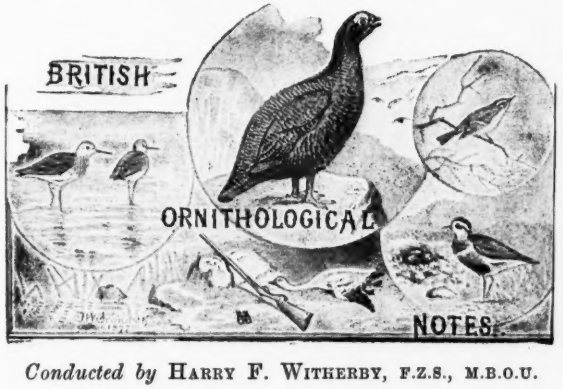
What is Life? By Frederick Hovenden, F.L.S., F.G.S., F.R.M.S. (Chapman & Hall.) Illustrated. 6s.

Do we Vary in Weight at Different Times in the Day? By W. W. Wagstaffe, B.A., F.R C.S (Adlard & Son.)

In Nature's Workshop. By Grant Allen. (Newnes.) Ill. 3s. 6d.

Edible British Fungi, An Annotated Catalogue of. By E. W. Swanton. (Huddersfield: The Museum Press.) 2s. 6d. net.

Whence and Whither. By Dr. Paul Carus. (Kegan Paul.) 3s. 6d.



Conducted by HARRY F. WITHERBY, F.Z.S., M.B.O.U.

THE SHRIKE'S "LARDER."—At the meeting of the British Ornithologists' Club, held in December, 1900, a very interesting discussion took place on the nature and use of the "larders" made by Shrikes. Mr. Hartert and the Rev. H. A. Macpherson believed that the victims were generally impaled for the greater convenience of tearing them in pieces. Mr. Howard Saunders was, however, inclined to think that it was intended as a reserve of food for the young birds. The motive for the "larder" is certainly somewhat obscure. More observation on the point is needed, and those who have opportunities for observing Shrikes would do well to carefully examine the "larders" and endeavour to discover the object of the birds in forming them. These "larders" are rarely of any size, and usually consist of only one or two objects impaled, nor are these necessarily near the nest of the bird, indeed they are usually found away from the nest. It seems doubtful too if the birds have ever been observed to revisit and devour any insect, animal or bird they have impaled.—H. F. W.

Tawny Owl in Ireland (Irish Naturalist, January, 1901, p. 24).—Mr. Robert Patterson records that a Tawny Owl *(Syrnium aluco)* was shot on November 16th, 1900, in a wood in Belvoir Park, co. Down, and sent to him in the flesh for inspection. The bird was shot by a gamekeeper merely for the purpose of filling an empty glass case. This is the first authentic record of the Tawny Owl in Ireland, and the only question is, was the bird an escape. On this point Mr. Patterson says that the plumage showed no trace of confinement, and that the stomach contained the remains of a full-grown rat. The bird was a female.

Pectoral Sandpiper in Ireland.—At the December meeting of the British Ornithological Club, Mr. Howard Saunders exhibited, on behalf of Mr. E. Williams, of Dublin, a specimen of the Pectoral Sandpiper (*Heteropygia maculata*). The bird was a young one, and was shot early in October, 1900, at Belmullet, in co. Mayo. Although this American wader has often occurred in England it has only once before been recorded for Ireland.

On some Migratory and other Birds observed in Southern Shetland in September, 1900. By Wm. Eagle Clarke, F.L.S., and T. G. Laidlaw, M.B.O.U. (*Annals of Scott. Nat. Hist.*, January, 1901, pp. 5—12). This is an interesting and valuable paper because, although the Shetlands have been long and thoroughly hunted by egg collectors, and the breeding birds are consequently well known, present knowledge of the migratory movements of the birds there is extremely scanty. The authors of these notes have added considerably to the little that is known by their short stay in September last. Perhaps the most valuable observations were made in connection with the White Wagtail (*Motacilla alba*). In his report on the migrations of birds to the last meeting of the British Association (*see* KNOWLEDGE, January, 1901, p. 18), Mr. Clarke expressed the opinion that the flocks of Pied Wagtails, said by Saxby to arrive in Unst in the autumn, would be found to be composed of White Wagtails. This surmise proved correct, as a number of White Wagtails were observed by the authors of these notes on the coasts of the southern portion of the main island. The number of other interesting observations of various species recorded in Messrs. Clarke and Laidlaw's paper show that visits by careful observers to the Shetlands during the migration season are sure to prove of value.

Notes on the White Wagtail (Motacilla alba. L.) in the South-east of Scotland. By William Evans, F.R.S.E. (*Annals of Scott. Nat. Hist.*, January, 1901, pp. 12—15). These notes are of interest when read in conjunction with Mr. Clarke's British Association paper on the migrations of the White Wagtail.

Notes on the Great Shearwater. By Howard Saunders (*Annals of Scott. Nat. Hist.*, January, 1901, pp. 15—18). Mr. Saunders here gives his authority with full particulars for his statement that the Great Shearwater on alighting "strikes the water with great violence, in a manner quite different from that of a gull, and then dives." This habit of the bird had been noted by Captain J. W. Collins, who had had "exceptional opportunities, extending over many years, for observing the aforesaid Shearwaters upon the fishing banks" off the Eastern coast of North America. Mr. Robert Warren had also noted the habit in some Great Shearwaters which he observed in Ireland in 1893. The breeding place of this bird, by the way, has yet to be discovered.

Fulmar breeding at Cape Wrath. (*Annals of Scott. Nat. Hist.*, January, 1901, p. 50.) Mr. Howard Saunders records that on July 10th, 1900, when passing *close* under Cape Wrath, "several Fulmars came circling round the yacht, and then went to the grassy slopes, on which we could see, with our glasses, birds which we had no doubt were Fulmars, sitting." Mr. Saunders adds, "The Fulmar may well be spreading, for at Soa (St. Kilda), on the 22nd of same month, there seemed to be more than ever."

Nest of Young Starlings in Winter (*Nature*, January 10th, 1901, p. 252). "R. H. F." writes to *Nature* on January 8th, as follows:—"While a friend was walking through his fields near Broxbourne on Sunday afternoon, the 6th inst., he noticed a Starling flying towards an old elm with some food in its bill, and on going up to the tree he found a nest containing young birds. No doubt they are dead by this time, on account of the severe cold, and the difficulty the old birds found in obtaining food for them."

The Origin and Meaning of the Names of British Birds. By A. H. Meiklejohn (*Zoologist*, November, 1900, pp. 511-516). In this paper the author gives some interesting particulars of the derivation of certain popular names of birds. Many names are imitative of the birds' cries, others refer to their colours or some distinctive characteristic, but the origin of many names is obscure and unsatisfactory, while that of some, such as the gull, auk, and garganey seems to be quite unknown.

All contributions to the column, either in the way of notes or photographs, should be forwarded to HARRY F. WITHERBY, *at 1, Eliot Place, Blackheath, Kent.*

THE PROGRESS OF SEISMOLOGY DURING THE NINETEENTH CENTURY.

By Charles Davison, sc.d., f.g.s.

Seismology as a science is a product of the latter half of the nineteenth century. Recalling earlier contributions to the subject, that which stands out the most prominently is John Michell's memoir on the cause and phenomena of earthquakes, read before the Royal Society in 1760. It is interesting to notice how Michell anticipates some of the results of later workers. He recognises, for instance, that the slow-period waves are propagated to far greater distances along the surface than the rapid vibrations which form the perceptible shock, and that the velocity of seismic sea-waves increases with the depth of the ocean. He suggests that the position of the epicentre may be determined by observations of the time of occurrence or the direction of the motion. And, though unable, as we still are, to ascertain the depth of the focus, he makes a "random guess" that, in the case of the Lisbon earthquake, it was not less than a mile or a mile and a half and probably not more than three miles. Michell's theoretical views exercised no slight influence on those of his successors. Their chief interest at present is to show how far we have travelled during the nineteenth century.

To describe adequately the progress that has been made would, therefore, be almost the same as to summarise our present knowledge. Nevertheless, there are certain salient features in the history of the subject to which at the beginning of a new century it seems desirable to direct attention.

(1) During the first half of the past century, the contributions were comparatively few in number. Among the most important may be mentioned Darwin's memoir on the volcanic phenomena of South America, and the commencement of the long series of earthquake-catalogues compiled with unfailing industry by Alexis Perrey of Dijon, between the years 1843 and 1874. It would be difficult to investigate the seismic history of any portion of the earth without recourse to one or more of Perrey's valued works.

(2) The foundation of seismology was laid in 1846, when Robert Mallet applied the known laws of wave-motion in solids to the phenomena of earthquakes. Obvious as such an application may seem at the present day, and suggested as it had been by Michell, Thomas Young and others, one cannot estimate Mallet's performance too highly. Though his views on many points are superseded, he threw fresh light on the bearing of facts already known, invented much of the existing terminology, and determined experimentally the velocity of earth-waves in several different rocks. The catalogue of recorded earthquakes, prepared with the help of his son, will long be a book of reference to seismologists. But Mallet's greatest achievement was the investigation, by methods due almost entirely to himself, of the earthquake which devastated the kingdom of Naples in December, 1857. No clearer evidence could be furnished of the abiding influence of his labours than the fact that, out of about 3000 observers of the recent Hereford earthquake, nearly 500 at once recorded the direction of the shock.

(3) To appreciate the importance of the next step, one has only to read first the article on "Earthquakes," published in 1877 in the *Encyclopædia Britannica*, and then that on the "Seismometer," which appeared nine years later in the same work. During the interval, seismographs based on scientific principles were invented by Profs. Ewing, Gray and Milne, and their value tested by records of numerous earthquakes in Japan. A modern seismological observatory, indeed, can hardly be regarded as complete if it does not contain either the Gray-Milne or Ewing's three-component seismograph.

While these instruments were expressly made to meet a long-felt want, we are indebted almost to accident for the use of the various forms of the horizontal pendulum which have proved so serviceable in the investigation of distant earthquakes. Hengeller in 1832, Gerard in 1851, Close and Zöllner in 1869, the Darwins in 1880, and von Rebeur-Paschwitz in 1887, all designed the instrument for purposes foreign to seismology, but nevertheless prepared the way for the detailed changes introduced during the last eight years by Milne, Ehlert, Grablovitz, Cancani, and Omori. Good results have also been obtained by means of the long and heavy pendulums favoured by Italian observers.

(4) Changes in the amplitude, period and direction of earthquake-vibrations are readily distinguished without instrumental aid; but seismographs have done more than merely add precision to the evidence of our senses. They have rendered manifest features of the earthquake-motion that would otherwise have passed unnoticed. Still more interesting are the revelations of the horizontal pendulum with regard to the pulsations of distant earthquakes. By the disturbance of magnetographs, levels, or lakes, the propagation of surface undulations to immense distances had been known for more than a century. For the fuller knowledge gained during the last twelve years, we are indebted to the late von Rebeur-Paschwitz and those upon whom his mantle has fallen—Prof. Milne, Dr. Agamennone, Mr. Oldham and others. Much still remains to be learnt in this fascinating field of inquiry, but it is no slight feat to have proved that, in an earthquake, two series of elastic waves traverse the body of the earth with velocities of not less than 9 and $5\frac{1}{3}$ kilometres per second respectively; while the slow-period undulations spread over the surface at the rate of 3 kilometres per second, the latter having been traced to distances of more than four-fifths of the earth's circumference. It is an achievement worthy of the last years of the century.

(5) While the more obvious earthquake-phenomena were well-known fifty years ago, closer study has revealed others of equal importance. Statistical inquiries have proved that earthquakes are far more numerous than was formerly supposed, the most modern estimate being that one takes place on an average every half-hour. Harmonic analysis of the seismic records of different countries indicates a distinct periodicity in the occurrence of earthquakes, the maximum of the annual period being as a rule in the local winter and that of the diurnal period at noon. The latest seismic maps, in which epicentres are marked instead of disturbed areas, have led to the conclusion that the most sensitive regions are those in which the mean surface-slope is greatest; while the Japanese earthquake of 1891 and the Indian earthquake of 1897 have shown how rapid may be the rate of terrestrial change.

(6) Following the example of Mallet, detailed histories of important earthquakes have been published by various workers during the last twenty years; particularly of the Ischian, Andalusian, Charlestown, Riviera, Zante, Laibach, Hereford and Indian earth-

quakes. Seismological committees or departments have been established in several countries. Thanks to the work of Milne and Omori in Japan, of Saderra and Coronas in the Philippines, of de Rossi, Agamennone, Baratta and Mercalli in Italy, of Eginitis and Papavasiliou in Greece, and many others, some of the finest seismic regions in the world are now secure from neglect. To the labours of von Rebeur-Paschwitz, Milne, and Gerland, in founding a seismic survey of the world, we may look forward with confidence to obtaining a rich harvest of results.

(7) Concurrently with the growth in our knowledge, the origin of earthquakes has become more clearly understood. There are many shocks, marked as a rule by small disturbed areas and abnormal intensity near the centre, which we can hardly err in attributing to volcanic action in some cases, and in others to local disturbances partly natural and partly artificial. But all severe earthquakes, and the majority of slight ones, we seem to be equally justified in connecting with the formation of faults. In regarding earthquakes as the passing effects of the gradual but intermittent growth of faults, we are relying on a source of energy competent to produce the strongest as well as the weakest shock. At the same time, we are investing earthquakes with a significance which they certainly did not possess for us at the beginning of the nineteenth century, as indices of the site and epoch of the changes that are now taking place in the earth's crust.

Conducted by M. I. Cross.

PHOTO-MICROGRAPHY.—One of the great difficulties experienced by novices in photo-micrography is in the attempt to get an evenly illuminated disc with a clear sharp edge. Various devices have been tried to accomplish this, including masks placed immediately in front of the plate during exposure, and cutting down the disc by means of a mask when printing from the negative, but these are really, so far as the disc is concerned, attempts to obliterate an original error of manipulation. The necessity for masking off a portion of the field during printing so as to get only the portion that is in focus in the centre is not now under consideration.

It is proposed to give directions which, if attended to, will ensure a clear, evenly illuminated disc with a sharp edge.

In the first place suitable apparatus is requisite, and in addition to the camera, microscope and objectives, the following should be included: illuminant—preferably zirconium or lime light—bull's-eye condenser *with iris diaphragm* immediately in front of it; substage condenser; projection eyepiece; and a piece of glazed cardboard about 6 inches square mounted on a wooden support so that it may be central with the optic axis of the microscope; a darkened room.

The microscopic object should be placed on the stage and the objective and substage condenser adjusted exactly as for a visual examination. The microscope is then set in position on the camera base. The cardboard should now be set up at a distance of about 6 inches from the eyepiece.

Light up, centre the jet or source of illumination as nearly as can be roughly done to the bull's-eye, then centre the bull's-eye to the microscope. This is done in the following manner:—

It will be observed that a faintly illuminated disc will appear upon the cardboard when light is passed through the condensers. The iris diaphragm attached to the bull's-eye must now be treated as the source of light, and the position of the bull's-eye altered until the centre of this iris diaphragm corresponds with the centre of the microscope. In order to do this exactly, the iris of the bull's-eye should be almost closed, and if the focus of the substage condenser be altered slightly the outline of this iris diaphragm will appear sharply upon the card. It should, after accurate centering, be opened to just such an extent as the circumstances allow. Next alter the adjusting collar carrying the eye-lens of the projection eyepiece so that a sharply defined edge is given to the disc.

It will now be necessary to centre the light to the bull's-eye, which together with its backward or forward position can be checked by allowing its image to fall upon a screen of card set at the back of the substage condenser, in the manner recommended in the various text-books.

If all these adjustments are made with care, and the iris of the bull's-eye opened to the proper extent, an evenly illuminated disc should result, and nothing remains but to view and finally focus the image upon the focussing screen and take the photograph, using of course such coloured glasses, etc., as the objects may necessitate.

A NEW HEATING STAGE.—Mr. Leonard P. Wilson, F.C.S., sends us the following description of a new heating stage of his own design. During the course of some recent crystallographic investigations, it was considered necessary to examine, microscopically, a number of substances at known constant temperatures. In order to do this, a heating stage was essential, but none of those in general use appeared to fulfil the requirements, the fault lying chiefly in the fact that the slide, being heated only from below, was cooled irregularly by currents of air. A stage was therefore designed in which the temperature of the slide could be accurately known, and could be easily controlled. The construction of this stage was such that the heating medium, generally water, flowed both above and below the slide, thus heating it uniformly, while air currents could only enter by the narrow aperture through which the slide and its carrier were introduced into the stage, the circular apertures

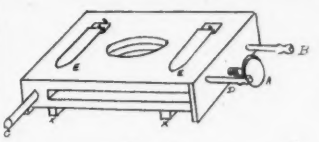


FIG. 1.

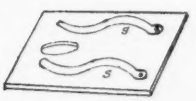


FIG. 2.

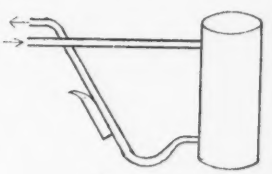


FIG. 3.

in the optic axis of the microscope being protected as hereafter described. As shown in Fig. 1, the stage is in the form of a double box, forming a water jacket to the slide and its carrier. Water of the required temperature is passed in at A, and flows out at B, the temperature being taken by means of a thermometer inserted into the tube C, round which the water passes in the middle of its course. The heating stage is fastened to the mechanical stage by means of the screw D. When using a high power, the objective passes into the upper aperture of the stage, and is below the level of its upper surface, and in order that the stage may move freely in all directions in conjunction with the movements of the mechanical stage, it is necessary that this tubular aperture be greater in diameter than the objective. To prevent the intrusion of cold air which might take place owing to this difference in diameter, a vulcanite plate, having an aperture which the objective just fits, slides on the surface of the stage, under the clips E, E. In a manner similar to the objective, the condenser passes up into the lower portion of the stage; space for the vulcanite plate in this case being made by the introduction of two bars X, X, across the lower surface of the stage, which is thereby raised above the mechanical stage. The slide carrier, as shown in Fig. 2, consists of a brass plate, having a circular aperture through it,

XUM

and having fixed to it two springs, S, S. By means of these springs the slide is held in position on the carrier, and the carrier is also held in position between the upper and lower plates of the stage. The slide can be roughly adjusted by means of the carrier, fine adjustment being made with the mechanical stage. The heating apparatus is as in Fig. 3, and by slightly raising or lowering the flame, the temperature can be regulated and kept constant within half a degree Centigrade.

Light Filters.—A few years ago it was pointed out by Mr. Nelson that the use of suitable light filters improved the working of objectives in a marvellous manner, that if the filter employed was practically of the same colour as the ray for which the spherical aberration of the objective was best corrected, a good modern achromatic lens would perform equally as well as an expensive apochromat.

The most practical and successful of light filters at present in use consists of a saturated solution of acetate of copper. This should be placed in a trough and intervene between the illuminant and the substage condenser.

The internal thickness of this trough should not be less than $\frac{5}{8}$ inch; $\frac{9}{16}$ inch barely causes the absorption of the red in the spectrum, $\frac{5}{8}$ inch exactly does it with an oil lamp having a $\frac{1}{2}$ inch wick. If a more brilliant illuminant be used, a greater depth of trough can without disadvantage be employed. We recommend a trial of this medium to all workers who would improve the definition of their object glasses.

Another advantage of a light filter of this description is that the full cone of the substage condenser can be used without the brilliance of illumination being so great as to cause the observer discomfort.

Notes and Queries.—*Communications and enquiries on Microscopical matters are cordially invited, and should be addressed to* M. I. Cross, Knowledge *Office, 326, High Holborn, W.C.*

NOTES ON COMETS AND METEORS.

By W. F. Denning, F.R.A.S.

Cometary Discoveries during the Nineteenth Century.—The extraordinary progress effected in all departments of astronomy during the past century is well exemplified in that branch relating to comets, for there were nearly four times as many new comets found between 1801 and 1900 as between 1701 and 1800, the relative numbers being 235 and 62. The century just concluded has, in fact, furnished us with many important items respecting these mysterious bodies. In 1800 only one periodical comet was known, viz., that of Halley's. At the present time we are acquainted with a large number, which are grouped into families, the most numerous and best known being those with aphelia, just outside the orbit of Jupiter. During the century just opened the field of cometary discovery will no doubt continue a very productive one, but it is not likely that the figures will show a great increase as compared with the last century. The rate of these discoveries has not exhibited any marked rise since the year 1840, and it is difficult to see how it can be much accelerated unless a more expeditious means of seeking for these bodies is adopted, or many more observers than hitherto apply themselves to the work.

Comet 1894 IV. (De Vico—E. Swift).—It is expected that this comet will arrive at perihelion on February 13th, but it will then be overpowered by the rays of the sun.

Brorsen's Comet.—This comet is moving rapidly to N.W., and ought to be well visible in February. No announcement of its re-discovery has, however, yet been made. In view of the fact that the comet has eluded detection at several previous returns its existence is a little questionable, and there appears some ground for the inference that it has, like the comet of Biela, suffered disintegration. It will, however, be diligently sought for by means of some of the large telescopes available for this kind of work, and we may shortly expect to hear of its re-detection if it revolves in the same orbit as formerly, and still visibly exists under the form of a comet.

New Comet.—A new comet is announced as having been discovered by M. Giacobini, at Nice, on December 20th. Its approximate position was R.A. 338°, Dec. S. 22°. On December 24th, 8h. 43m., G.M.T., its place was R.A. 344½°, Dec. S. 22¾°, so the object is moving about 1½° per day to the E.S.E. During the last few years M. Giacobini's discoveries of comets have been rather numerous and important, and in recognition of his successful labours in this field the French Academy of Sciences has recently awarded him the Lalande Prize.

Autumn Meteors.—In October and November Prof. A. S. Herschel, of Slough, observed 120 meteors, and determined the positions of the chief radiants as follows:—57° + 9° (11 meteors), 57° + 18° (11), 56° + 28° (8), 70° + 35° (8), 80° + 18° (6), 75° + 13° (4), 44° + 24° (9), 44° + 12° (10). The first two radiants represent well-defined showers of Taurids.

The Geminids.—On December 13th the sky was beautifully clear, and a number of meteors were observed at various places. At Slough Prof. Herschel watched from 11¼h. to 13¼h. and recorded about 20 meteors, including two fine ones, as follows:—

11h. 58m.—Magnitude twice as bright as Venus. Path of about 35 degrees from ζ Persei to halfway between β and γ Arietis. Probable radiant 167° + 5°.

12h. 26m.—Magnitude equal to Jupiter. Path from 1° N. of λ Orionis to 1° S. of γ Tauri. Moved over 30° in ¾ second. Probable radiant 121° − 1°.

About one-third of the meteors seen were Geminids with the usual short tracks and quick motions.

Mr. T. H. Astbury, of Wallingford, watched the sky on December 13th between 8h. 10m. and 9h. o'clock, and registered 14 meteors, of which 12 were Geminids, the centres of radiation being 109° + 35° and 113° + 32°. A later observation from 9h. 50m. to 10h. 30m. furnished three additional Geminids, but the shower appeared to have greatly declined as compared with its unusual activity earlier in the evening.

Mr. C. L. Brook, at Meltham, near Huddersfield, observing for 2½ hours on December 11th, between 9h. and 12h., saw 19 meteors, of which 11 were Geminids. On December 12th he watched 3h. 25m. of the interval between 8h. and 12¼h., and saw 25 meteors, including 17 Geminids. Between 10h. 51m. and 11h. 35m. no less than 13 Geminids were recorded.

On December 13th, 10h. 18½m., a rather fine δ Geminid, brighter than a first magnitude star, was observed by Mr. A. King, of Leicester, and Mr. T. H. Astbury at Wallingford. The meteor fell from a height of 59 to 44 miles, and its course lay from nearly over Hertford to Luton. Length of path 24 miles, and earth point 8 miles west of Banbury.

Fireballs.—Several of these striking objects have been recently observed from various parts of the country. The dates and times were as under:—November 27th, 11h. 10m.; December 1st, 4h. 12m. and 12h.; December 10th, 3h. 55m. a.m.; December 16th, 7h. 35m. a.m.; December 17th, 5h. 55m. p.m. Mr. G. Herbert Price, of Brixton Hill, S.W., also reports a bright meteor seen on December 13th, 9h. 20m., traversing a path from Gemini to the region of Aries. A rather sensational incident occurred on Saturday night, December 22nd, according to the *Pall Mall Gazette*, which states that "a large meteorite fell at Great Parndor, Essex. Frederick Armour, a local postman, who was passing the field in which it fell, states that he was blinded and stunned by the brilliant flash of light. He was found unconscious in the roadway."

Fireball in Sunshine.—On January 6th, 1901, at 0h. 52m. p.m., a large meteor was observed from various places in Scotland and the extreme N. of England. As seen from Glasgow the object is described as a large ball of fire with a long streaming tail. The meteor disappeared in the N.W. quarter at rather a low altitude, and it was directed from the E.N.E., so that the probable radiant was in the region of Perseus or Aries. Mr. W. H. S. Monck has kindly sent me several newspaper accounts of the fireball, but they are wanting in some of the definite particulars necessary for the computation of the real path. There was a brilliant meteor seen in sunshine on January 9th, 1900 (*see* Knowledge, February, 1900, p. 47), but this object must have emanated from a different stream to that which furnished the more recent meteor. It is astonishing how many large meteors have been observed even in the presence of the sun, and it proves that they are unusually prevalent in the day-time. Unfortunately, however, they are seldom well observed as regards their position and direction of flight.

THE FACE OF THE SKY FOR FEBRUARY.

By A. Fowler, F.R.A.S.

The Sun.—On the 1st the sun rises at 7.42 A.M., and sets at 4.46 P.M.; on the 28th he rises at 6.51 A.M. and sets at 5.35 P.M. Few sunspots are to be expected. The Zodiacal Light may be looked for in the west after sunset.

The Moon.—The moon will be full on the 3rd at 3.30 P.M., will enter last quarter on the 11th at 6.12 P.M., will be new on the 19th at 2.45 A.M., and will enter first quarter on the 25th at 6.38 P.M. The following

are among the more interesting occultations which occur at convenient times during the month:—

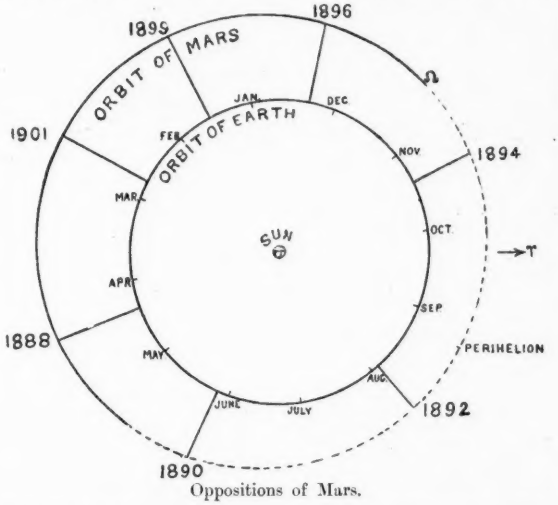
Date.	Name.	Magnitude.	Disappearance.	Angle from North.	Angle from Vertex.	Reappearance.	Angle from North.	Angle from Vertex.	Moon's Age.
				°	°		°	°	d. h.
Feb 1	D.M.+17°1596	5·6	6.32 P.M.	146	186	7·18	231	269	12 4
,, 21	51 Piscium	5·7	6.54 P.M.	76	38	7·51	245	206	2 17
,, 22	π Piscium	5·6	10.20 P.M.	97	59	11·7 ‡	237	203	3 20

‡ Star below horizon.

THE PLANETS.—Mercury is an evening star throughout the month, reaching an easterly elongation of 18° 6′ on the 19th. About this time he will be well placed for observation, as he remains above the horizon nearly an hour and three quarters after the sun has set. The planet will be found a little south of west. On the evening of the 20th the planet will be a few degrees to the south-west of the moon. There are no bright stars near the planet.

Venus is a morning star throughout the month, but not well placed for observation. On the 14th, the illuminated part of the disc is 0.949, and the planet does not rise until nearly 7 A.M.

Mars arrives at opposition on the morning of the 22nd, and may be observed throughout the greater part of the night. He remains in Leo, rising shortly after 7 P.M. on the 1st, and before 4.30 P.M. on the 28th. As will be seen from the appended diagram the opposition is by no means one of the most favourable, the



Oppositions of Mars.

distance of the planet from the earth being close upon 60 millions of miles, as compared with 35 millions at the most favourable oppositions. The apparent diameter of the planet at the time of this opposition is 13″.8. It is winter in the southern hemisphere of Mars, and the north pole is turned towards the earth.

Jupiter, Saturn, and Uranus are morning stars, but not very well placed for observation. On the 14th they rise respectively at 4.54 A.M., 5.21 A.M., and 3.49 A.M. Jupiter and Saturn are in Sagittarius, Uranus in the most southerly part of Ophiuchus.

Neptune remains in the most easterly part of Taurus, and during the month traverses a very short westerly path nearly midway between 132 Tauri and χ^1 Orionis.

THE STARS.—About 9 P.M. at the middle of the month, Ursa Major will be in the north-east; Arcturus rising in the north-east; Leo a little south of east; Cancer and Hydra in the south-east; Gemini and Auriga nearly overhead; Canis Minor and Canis Major near the meridian; Orion a little west of south; Taurus in the south-west; Aries and Perseus in the west; and Andromeda and Cassiopeia towards the north-west.

A minimum of Algol will occur on the 15th at 11.21 P.M., and another on the 18th at 8.10 P.M.

Chess Column.

By C. D. LOCOCK, B.A.

Communications for this column should be addressed to C. D. LOCOCK, Netherfield, Camberley, and be posted by the 10th of each month.

Solutions of January Problems.

(W. Geary.)

No. 1.

1. Kt to R5, and mates next move.

No. 2.

Key move—1. Q to QKt3.

If 1. . . . Kt or RP moves, 2. Kt to Kt3ch.
1. . . . K or KtP moves, 2. Kt to K6.

[Kt to Q3 and Kt to KKt2, given by several correspondents as keys to No. 1, fail on account of the reply 1. . . . KtP × R.]

CORRECT SOLUTIONS of both problems received from J. Baddeley, H. Le Jeune, B. Harley, G. Groom, F. J. Lea, G. A. Forde (Capt.), S. G. Luckcock, W. de P. Crousaz, W. H. S. M., J. T. Blakemore, N. K. Dutt, Enderby, F. Dennis, C. L. Massey, Eugene Henry, A. J. Head, G. W., J. Sowden, G. W. Middleton, T. H. Billington, C. Johnston, H. Boyes, A. C. Challenger, E. Hunt, Vivien H. Macmeikan, W. E. P., A. Dod, W. Jay, A. E. Whitehouse, W. Geary, W. Boyd, C. F. P., S. W. Billings, N. B., W. B. Alldritt, W. F. P., T. Earl, J. E. Broadbent, C. Child, C. S. Hudson.

Of No. 1 only from J. M. K., J. A. Nicholson, W. Nash, C. C. Pennington, J. Bernard Corp.

Of No. 2 only from A. H. Machell Cox, L. J. R. Cripps, J. T. Stockwell, H. L. Gillespie, H. S. Brandreth, J. W. Meyjes, Alpha, W. Smith, F. Stokoe, J. Neville.

P. A. Cobbold.—Solution of No. 2 (December) correct. No. 1, however, cannot be solved by 1. B to R4, on account of 1. . . . B to Q7 (!), when 2. R to Q4 is not mate. So also, if 1. B × KP, B to B5. Both are good "tries" Of course it would be impossible for you to post in time from Canada.

G. A. Forde.—Thanks for your suggestion. I think, however, that to start numbering the problems continuously from the present time would convey a false impression of the antiquity of this page. In the case of a monthly magazine, there is no difficulty in referring to any problem, *e.g.*, as "No. 2 of June, 1897," or "No. 1 of May, 1926," etc.

A. W. Tyer, J. M. K., and others.—1. Q to QB3 is answered by P to Kt6; and, if then 2. Kt to K6, K to Q4.

F. Dennis.—Besides giving point to the problem, the KB is necessary in Mr. Allen's December problem. At any rate the composer had to stop any immediate check at K7 with the Rook, and if he uses a Black Pawn for that purpose, it must be pinned by a Bishop in view of

K×Kt. No doubt the problem could have been constructed without it.

J. M. K.—I should say that there would be no objection to it.

H. L. Gillespie.—If 1. B×P, B×R, or KP×P are valid defences.

J. W. Meyjes.—If 1. Kt×P, P×R; or if 1. Kt to R3 the same applies I regret that you should score −1 according to the rules.

G. W.—Certainly; postcards are preferred.

Alpha.—I agree that "key only" is a very liberal condition in the case of three-movers. It saves, however, a good deal of trouble, from clerical errors and otherwise, and gives comparative novices a better chance of keeping up with expert solvers. In the end it would be safe to say that a solver not capable of seeing the correct second moves would have little chance of winning a solution tournament extending over a year.

W. H. Gundry.—Thanks for the problem, which appears below.

J. Sowden.—Yes; postcards are preferred.

G. W. Middleton.—No points are given for proving a position to be impossible in actual play.

C. C. Pennington and *J. Bernard Corp.*—If 1. K to K6, Kt to B3.

J. W. Hobbs.—1. K to B6 will not solve No. 2.

F. Stokoe —1. Kt to R3 is answered by P×R. It is strange that so many solvers have overlooked this defence.

W. E. P.—A second solution is the same as a cook; but not more than three points can be scored for a two-mover, or more than four points for a three-mover, even if a problem has a dozen keys.

J. Neville.—Many thanks, but I fear there is no space for any matter concerning a single county only.

C. F. P.—It is necessary to provide for the event of a problem having no solution. The best composers occasionally overlook some obscure defence. To avoid the waste of time which you deprecate, no three-move problem known to have no solution will be printed.

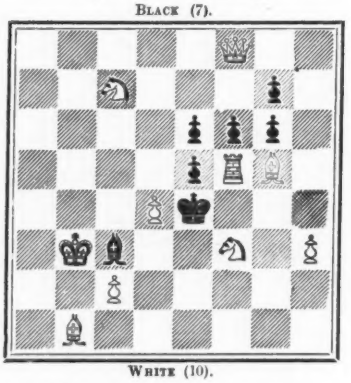
C. S. Hudson.—Much regret the unfortunate lateness, but fear that the rule leaves no option.

PROBLEMS.

No. 1.

By W. H. Gundry.

BLACK (7).



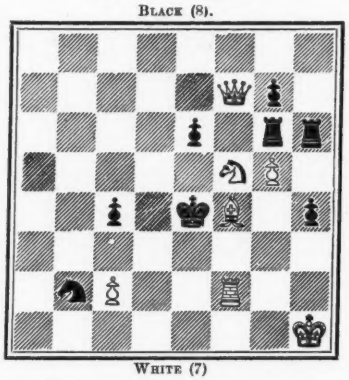
WHITE (10).

White mates in two moves.

No. 2.

By B. G. Laws.

BLACK (8).



WHITE (7)

White mates in three moves.

Owing to the large number of solvers this month—fifty-eight sent in solutions—it has been decided to give, as equal third and fourth prizes, KNOWLEDGE for six months. It is hoped that those who have temporarily lost a point or two will not immediately withdraw from the contest. Some of the problems due to appear will give them excellent chances of recovery, being of a nature to deceive probably a good many of those who now head the score.

CHESS INTELLIGENCE.

There were only four entries this year for the Craigside Challenge Cup Competition. Mr. A. Burn proved the winner with a score of 3 wins, 3 draws, and no losses, one point of Mr. H. E. Atkins who scored 3½, losing both games to Mr. Burn. Mr. W. H. Gunston was third with 2½, and Mr. G. E. H. Bellingham fourth and last with 1. In the other principal tournament Mr. A. Dod was first, and Mr. C. H. Sherrard second. Mr. Billington, one of our solvers this month, won the second-class event. Mr. Dod, we are glad to see, has also entered for the present competition. It is almost safe to predict that anyone who gets ahead of these two will come very near winning.

The entries for the International Tournament at Monte Carlo include, so far as is known at present, the names of Messrs. Blackburne, Cohn, Lipschütz, Mason, Marco, Mieses, Schlechter, Tchigorin and Winawer, a strong, though not quite a representative list in the absence of Lasker, Maroczy, Janowski, Pillsbury and Burn.

The very short tournament at Simpson's Divan was won by R. Teichmann; the remaining competitors, Messrs. Müller, Lee, Van Vliet, and Mortimer, coming out in the order mentioned.

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